The nonlinear relationship between banks competition and financial stability in China

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ABSTRACT
We use difference GMM method to investigate the influence of banks competition on financial stability in China. The result shows there is an optimal competition level for China’s banks system. The stock market disaster in 2015 does not have significant influence on the z scores of banks, but it caused the non-performance loans increase evidently. This may be the results of China’s separate supervision and separate operation of financial system. Appropriate competition level is essential for China’s banks system.

I. Introduction
Since 2008 global financial crisis, financial stability has become the focus of policy concern. For the past decades, the establishment of many new domestic and foreign banks dramatically increased China’s banks competition and risks. The bankruptcy of Bao-shang Bank alarmed the market to concern the stability of China’s banks.

Fierce competition will lead to insufficient margins and profits, which caused banks’ failure recently. Lack of competition leads to higher loan rates and increases the burden for borrowers. The public guarantees or subsidies for big banks make banks behaviour more risky and damage financial stability.

We test the relationships between banks competition and financial stability. We use z scores and non-performing loans for financial stability and Lerner index for competition. We also use a dummy variable for stock disaster to test its impact on financial stability.

II. Basic theories
Competition-stability: A more powerful bank system tends to charge higher loan rates, which induce borrowers to assume greater risk and greater default and finally threatens the financial stability. In a concentrated banking system, large banks are more likely to receive public guarantees or subsidies (Mishkin 1999), which may encourage banks’ risk-taking behaviour and intensify financial fragility. Schaeck and Cihak (2008) find competition increases the efficiency and soundness of banking system for European and US banks. Anginer, Demirgüc-Kunt, and Zhu (2012) use Lerner index and default risk under contingent claim pricing framework (Robert 1974) to find a positive relationship between competition and banks stability.

Competition-fragility: Fierce competition makes banks to engage in riskier activities for higher returns and reluctant to provide liquidity to their vulnerable counterparts. More monopoly brings higher franchise value for the bank; this may prevent excessive risky behaviour. The higher opportunity cost of bankruptcy leads to less dangerous decisions of banks, thereby improving the quality of bank assets (Nguyen, Le, and Tran 2017). Keeley (1990) find that increased competition and deregulation in US banking system lead to bank failures during 1990s. Berger, Klapper, and Turk-Ariss (2009) find that concentrated banking system will expose to less overall risks.
III. Methodology

Measurement of banks’ stability

Z score is the widely used index to measure commercial banks risk (Boyd 1993). The accounting data Z score is

\[ Z_{it} = \frac{\text{ROA}_t + \varepsilon_{it}}{\sigma_{\text{ROA}, t}} \]

(1)

where ROA is the return on assets, E/TA is the equity to total assets ratio, and \( \sigma_{\text{ROA}} \) is the standard deviation of return on assets.

When its asset value drops below its debt, a bank becomes insolvent and the Z score shows the number of standard deviations that a bank’s return has to fall below its expected value to deplete equity and make the bank insolvent.

Measurement of competition

We use Lerner index, which is the mark-up of price over a bank’s marginal cost, to measure the market power of banks.

\[ \text{Lerner}_{it} = \frac{P_{it} - \frac{\partial c_{it}}{\partial y_{it}}}{P_{it}} \]

(2)

Where \( P_{it} \) is the average price of bank i’s output at time t, calculated by the ratio of total income to total assets. \( c_{it} \) is the bank’s total cost and \( y_{it} \) is its output. Bank markets are perfect competition, when \( \text{Lerner}_{it} = 0 \), and the competition increased as the \( \text{Lerner}_{it} \)’s value increases.

The main task is to estimate the marginal cost of banks \( \frac{\partial c_{it}}{\partial y_{it}} \) from the banks’ total cost function (Fu, Lin, and Molyneux 2014).

\[ \ln c_{it} = \alpha_0 + \sum_{j=1}^{3} \alpha_j w_{it}^j + \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} \alpha_{jk} \ln w_{it}^j \ln w_{it}^k + \beta_1 \ln y_{it} + \beta_2 (\ln y_{it})^2 + \sum_{j=1}^{3} \beta_{j} \ln y_{it} \ln w_{it}^j + \varphi_{it} \times T + \frac{1}{2} \varphi_{2it} \times T^2 + \sum_{j=1}^{3} \varphi_{3it} \times T \times \ln w_{it}^j + \varphi_{4it} \times T \times \ln y_{it} + u_t + \varepsilon_{it} \]

(3)

c\(_{it}\) is the total costs of bank i at year t and is equal to the sum of interest expenses, commission and fee expenses, trading expenses, personnel expenses, administrative expenses. \( y_{it} \) is the quantity of output and is measured as total assets. \( w_{it}^j \) are the prices of inputs. \( w_{it}^j \) is the ratio of interest expenses to total assets, \( w_{it}^j \) is the ratio of personnel expenses to total assets, \( w_{it}^j \) is the ratio of administrative and other operating expenses to total assets. T is the time trend reflecting the effect of technical progress, \( \mu \) captures the individual fixed effects, and \( \varepsilon_{it} \) is the error term.

We use the method of fixed effects to estimate banks total cost function (3) and get the coefficients for marginal cost in (4).

\[ MC_{it} = \frac{c_{it}}{y_{it}} \left( \beta_1 + \beta_2 \ln y_{it} + \sum_{j=1}^{3} \beta_{j} \ln w_{it}^j + \varphi_{4it} T \right) \]

(4)

Which is the derivative of total cost function with output in Equation (3). Then we can work out the Lerner indexes as Equation (2).

Empirical models

We estimate the following two equations for the linkage of competition and financial stability. The first one is a dynamic model, which includes the latencies of the dependent variable as an independent variable. We only consider the first latency for the relative small sample.

\[ \ln(z_{it}) = \alpha_t + \delta \ln(z_{i,t-1}) + \beta_1 \text{Lerner}_{i,t} + \beta_2 (\text{Lerner}_{i,t})^2 + \beta_3 \text{Size}_{i,t} + \beta_4 \text{Loanta}_{i,t} + \epsilon_{i,t} \]

\[ \text{NPL}_{it} = \alpha_t + \delta \text{NPL}_{i,t-1} + \beta_1 \text{Lerner}_{i,t} + \beta_2 \text{Lerner}_{i,t}^2 + \beta_3 \text{Size}_{i,t} + \beta_4 \text{Loanta}_{i,t} + \epsilon_{i,t} \]

\( \ln(z_{i,t}) \) is the natural logarithm of Z score and NPL presents banks’ risk. Lerner index delegates the competition level of banks market. The square of Lerner index measures the non-linear relationship between competition and stability. We control bank-specific variables such as Bank size measured by the logarithm of total assets, the ratio of total
loans to total assets. Use dummy variable for the impact of stock disaster in 2015. The model takes the forms of

$$
\ln(z_{it}) = \alpha_i + \delta \ln(z_{i,t-1}) + \beta_1 \text{Lerner}_{i,t} + \beta_2 \text{Lerner}_{i,t}^2 + \beta_3 \text{Crisis}_{i,t} + \beta_4 \text{Size}_{i,t} + \beta_5 \text{Loanta}_{i,t} + \epsilon_{i,t}
$$

$$
\text{NPL}_{i,t} = \alpha_i + \delta \text{NPL}_{i,t-1} + \beta_1 \text{Lerner}_{i,t} + \beta_2 \text{Lerner}_{i,t}^2 + \beta_3 \text{Crisis}_{i,t} + \beta_4 \text{Size}_{i,t} + \beta_5 \text{Loanta}_{i,t} + \epsilon_{i,t}
$$

We use the Lerner index times the dummy variable of stock disaster to test the dual influences on financial stability.

$$
\ln(z_{it})=\alpha_i+\delta \ln(z_{i,t-1})+\beta_1 \text{Lerner}_{i,t}+\beta_2 \text{Lerner}_{i,t} \times \text{Crisis}_{i,t}+\beta_3 \text{Size}_{i,t}+\beta_4 \text{Loanta}_{i,t}+\epsilon_{i,t}
$$

(9)

$$
\text{NPL}_{it}=\alpha_i+\delta \text{NPL}_{i,t-1}+\beta_1 \text{Lerner}_{i,t}+\beta_2 \text{Lerner}_{i,t} \times \text{Crisis}_{i,t}+\beta_3 \text{Size}_{i,t}+\beta_4 \text{Loanta}_{i,t}+\epsilon_{i,t}
$$

For the non-strict, exogenous of independent variables which may correlated with past and current realizations of the error and the ‘small T, large N’, we use difference GMM in the study.

IV. Data and results

The data is from 22 commercial banks in China for the period 2010 to 2019, obtained from CSMAR database.

Variable descriptive statistics

From Table 1, the average $\ln(z_{\text{score}})$ of the sample banks is 1.9705, the most stable bank has a $\ln(z_{\text{score}})$ of 2.6484, the lowest stability bank is 0.6331. The average Lerner index is 0.4827, indicating a high market power of banks. The data for NPL only including 14 Chinese fund banks for data lacking.

Empirical results

We use difference GMM to regress Equations (5)–(10) for dependent variables of z score and NPL. We first consider the impact of competition and then the impact of stock disaster, the last is the impact of competition with stock disaster.

Table 2 shows the results of DGMM estimations. The numbers in parentheses are the standard errors of coefficients.

### Table 1. Variables descriptive statistics.

| Variables | Definition | Mean | Min | Max | Std |
|-----------|-----------|------|-----|-----|-----|
| $\ln(z_{i,t})$ | The logarithm of z score, non-performing | 1.9705 | 0.6331 | 2.6484 | 0.4103 |
| NPL | Total loans | 0.0023 | 0.0002 | 0.0060 | 0.0014 |
| Lerner | $L = \frac{MC - MC}{MC}$ | 0.4827 | 0.1598 | 0.8978 | 0.1831 |
| Banksize | $\ln($Total assets $)$ | 27.5481 | 22.6518 | 31.0559 | 2.4523 |
| Loanta | Total loans | 0.4904 | 0.2640 | 0.7912 | 0.0854 |
| Stock disaster | value = 1, when the year is 2015, otherwise 0 | 0.1 | 0 | 1 | 0.3007 |

Source: calculating with Eviews 10.

### Table 2. Banks competition and stability.

| Model | $\ln(z_{i,t})$ | $\ln(z_{i,t-1})$ | Lerner | Lerner$^2$ | Bank size | Loanta | Stock disaster | $Lerner \times \text{disaster}$ | Hanson p value | P value of AR(1) |
|-------|----------------|-----------------|--------|-----------|-----------|--------|----------------|-----------------|----------------|-----------------|
| (5)   | 0.2721*** (0.0463) | 0.3300*** (0.0463) | -0.4742*** (0.1271) | -0.4283*** (0.2468) | 0.4823*** (0.1174) | 0.4478* (0.2518) | 0.0789*** (0.0152) | 1.3913*** (0.0751) | 0.0090(0.0099) | 0.6552 |
| (7)   | 0.2643*** (0.0380) | 0.4269*** (0.2468) | 0.0385(0.0313) | 0.4478* (0.2518) | 0.0263(0.1073) | 0.0924*** (0.0263) | 1.4136*** (0.0975) | 1.4274*** (0.1073) | 0.0058(0.0277) | 0.6552 |
| (9)   | 0.2643*** (0.0380) | 0.4269*** (0.2468) | 0.0385(0.0313) | 0.4478* (0.2518) | 0.0263(0.1073) | 0.0924*** (0.0263) | 1.4136*** (0.0975) | 1.4274*** (0.1073) | 0.0058(0.0277) | 0.6552 |

Source: calculated with Eviews 10.
Table 3. Banks competition and non-performance loan.

| Dependent variable | NPL | (6) | (8) | (10) |
|--------------------|-----|-----|-----|------|
| NPL<sub>-1</sub>   | 0.5513*** (0.0802) | 0.4619*** (0.0769) | 0.5101*** (0.1208) |
| Lerner             | -0.0142*** (0.0041) | -0.0136*** (0.0049) | -0.0032*** (0.0013) |
| Lerner<sup>2</sup> | 0.0136*** (0.0046)  | 0.0152*** (0.0042)  |                  |
| Banksiz<sup>e</sup> | 0.0012*** (0.0001)  | 0.0013*** (0.0001)  | 0.0014*** (0.0002) |
| Loan<sup>a</sup>   | -0.001 (0.0007)     | -0.0003 (0.0013)    | -0.0016 (0.0020)  |
| Stock disaster     |                  | -0.00001 (0.0003)   |                  |
| Lerner × disaster  |                  |                  | -0.0005*** (0.0002) |
| Hanson p value     | 0.2363            | 0.2665            | 0.2630             |
| p value of AR(1)   | 0.0075            | 0.0193            | 0.0507             |
| p value of AR(2)   | 0.2774            | 0.5846            | 0.2595             |

Source: calculated with Eviews 10.
Note: The symbols in this table are the same as those in Table 2.

***, ** and * indicate significance at the 1%, 5% and 10%. Coefficient without star means not significant.

For dependent variable of Z score, the p values of the three models exceed 10%, indicating no first order correlations in the residuals. P values of Hanson test in the six models are all greater than 5%, indicating the instrument variables of the models are suitable. Table 3 shows the NPL models have a p value of AR (1) less than 5% and a p value of AR (2) greater than 5%. The residuals have first-order correlations but no second-order correlations. The p values of Hanson test are greater than 5%, so the instrument variables of the models are suitable.

The coefficients of Lerner and Lerner<sup>2</sup> are significant at 1%, and the former is negative and the latter is positive. That is more market power of the banks leads to financial instability. The positive coefficient of Lerner<sup>2</sup> means an inversed U-shaped relation between competition and stability. In Equation (9), the coefficient of stock disaster is not significant. In Equation (11), the negative but not significant coefficient of Lerner × disaster means the stock market crash has not a direct impact on financial stability, which may be due to the separate supervision and separate operations of China’s financial system.

For the NPL model, there is a U-shaped relationship between the banks market power and non-performance loan as shown in Table 3. Specially, the coefficients of Lerner index for the three models of NPL are both negative and significant at least in 5%, and the coefficients of Lerner square is positive and significant at 1% level in models (8) and (10). When the banks do not have sufficient market power, the increasing of monopoly can reduce the non-performance loan, or we can say competition damage the stability of banks. The banks market power exceeding the essential level will cause non-performance loan rise; the ‘competition-stability’ holds on. When the competition is insufficient, increasing competition can reduce risky loans and loan interests thus less non-performing loans. When the competition exceeds essential level, excessive competition makes riskier activities, and non-performance loans increase.

Model (10) shows the stock market disaster does not have significant impact for the prohibition of banks entering the stock market directly. Model (12) indicates that competition in the context of stock disaster has deteriorated bank loans, for the coefficient of Lerner × disaster is significantly negative at 1% level. In such a context, banks have to make more risky loans and more non-performance loans produced.

Both models of NPL and z score have a significant momentum effects, for the last value of the dependent variables have significant influence on the current dependent value.

V. Conclusions

The results show the U-shaped relationship between banks competition and financial stability in China. There is an optimal competition level for the China’s financial stability. We also find there exist momentum effects of the banks stability, and the stock market disaster has no significant influence on financial stability. This may be due to the separate supervision
and separate operation of China’s finance system. Regulators should evaluate and approve banks merger and acquisitions more cautiously. Reducing policy lending can prevent the rising of non-performance loan and encourage independent credit cultures of banks greatly. There should be stricter scrutiny of foreign banks’ acquisitions in China.

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