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ABSTRACT

This paper tests the interrelationships among risk, competition, and efficiency in the Chinese banking industry between 2003 and 2013, with an efficiency-adjusted Lerner index and stability inefficiency as the indicators of competition and insolvency risk. The results show that Chinese commercial banks with higher efficiency have higher credit risk and insolvency risk, but lower liquidity risk and capital risk. Greater competition decreases credit risk and insolvency risk, but increases liquidity risk. Credit risk and insolvency risk are significantly and positively related to efficiency, while liquidity risk and capital risk are significantly and negatively related. Finally, lower liquidity risk decreases competition.

JEL classifications:

B22

C14

G21

Keywords:

Competition

Risk

Efficiency

Chinese banking

1. Introduction

China's economic development has attracted great attention from the rest of the world. During the period 2003–2013, China had an annual GDP growth rate of over 10.2%. The Chinese banking sector has undergone sustainable and healthy development through several rounds of banking reforms initiated by the government since 1978. The main purpose of these reforms has been to increase competition, enhance stability, and improve the performance of the Chinese banking sector; and indeed, competition has increased significantly. State-owned commercial banks (SOCBs) still dominate the industry. However, according to statistics from the China Banking Regulatory Commission (CBRC, 2013), their share of total banking sector assets decreased between 2003 and 2013, to a low point of 43.3%. On the other hand, joint-stock commercial banks (JSCBs) and city commercial banks (CCBs) kept growing; in 2013 they held 17.8% and 10.03% of total banking sector assets, respectively. Figure 1 shows the assets of SOCBs, JSCBs, CCBs, and total banking institutions in China over the period 2003–2013.

<<Figure 1 about here>>

Over the same period, the Chinese banking industry also reduced its credit risk undertaken. Ratios of loans in default during 2011–2013 were at 1%, lower than the figures for 2008–2010.[1] The industry also reduced its capital risk. CBRC statistics show

[1] There is a common skepticism, and many analysts have accused Chinese authorities of underreporting bank risk as a way to artificially support confidence. We cross-check the data reported by CBRC against data collected from Bankscope. The information from Bankscope is taken by Bureau Van Dijk from a combination of annual reports, information providers, and regulatory sources. More than 200 validation controls are

that, by the end of 2013, the average capital adequacy ratio of Chinese banks was 12.2%, up by 1.6% from the previous year. In addition, the liquidity ratio of Chinese commercial banks was 44% by the end of 2013. Although this ratio was lower than the figure for 2012, which was 45.8%, it was higher than those for 2010 and 2011, at 42.2% and 43.2%, respectively.

Few studies investigate competitive conditions in the Chinese banking sector (Fu, 2009; Masood & Sergi, 2011; Park, 2013; Tan, 2014; Tan & Floros, 2013a; Yuan, 2006). More importantly, although a few studies examine the effect of competition on banks' risk taking (Fu et al., 2014; Schaeck & Cihak, 2014; Soedarmono et al., 2013), three studies use data from the Chinese banking industry (Tan, 2014; Tan & Floros, 2013b, 2014). These papers mainly focus on credit risk or insolvency risk, and do not consider other types of risk such as capital risk and liquidity risk. The impact of competition on capital risk and liquidity risk has policy implications for Chinese banking regulators, but the current empirical literature does not provide a clear estimate of this impact for China. There are also few empirical studies examining the performance of Chinese commercial banks (Sun et al., 2013; Tan, 2014; Tan & Floros, 2013b). To our knowledge, there is no empirical study examining the effect of competition and different types of risk on efficiency in the Chinese banking industry.

We use a sample of Chinese commercial banks (SOCBs, JSCBs, and CCBs) to test the interrelationships among efficiency, risk, and competition. Our study controls for a number of variables that are thought to influence those factors: bank-specific

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applied to the data, which are checked entity by entity and reviewed regularly. The data in the current paper come not only from CBRC, but also from Bankscope and World Bank databases.

variables (size, profitability, and diversification); industry-specific variables (banking sector development and stock market development); and macroeconomic variables (inflation and annual GDP). Data come from three sources, the China Banking Regulatory Commission (CBRC), Bankscope, and the World Bank database. We use nonparametric Data Envelopment Analysis (DEA) to measure efficiency; accounting ratios as well as a translog function to measure different types of risk; and the efficiency-adjusted Lerner index to measure competition. To test the interrelationships among efficiency, competition, and risk, we use the well-known statistical (econometric) Granger-causality test.

This paper is the first to investigate technical efficiency and pure technical efficiency as well as scale efficiency, reflecting both inside and outside factors influencing bank performance. In other words, we investigate the source of inefficiencies (either from bank management of inputs and outputs or from scale of operation) and their interrelationships with different types of risk and competition (which have important policy implications). This is also the first paper to test competition in the Chinese banking industry using the more accurate efficiency-adjusted Lerner index rather than the traditional Lerner index (Amidu & Wolfe, 2013), and to test the robustness of the reported results using alternative indicators of competition and risk as well as different econometric techniques.

The remainder of the paper is organized as follows: section 2 reviews the literature on the interrelationships among risk, efficiency, and competition in the banking industry, while section 3 describes the data, the institutional background, and the methods. Section 4 discusses the empirical results. A robustness check is provided in section 5, and section 6 summarizes and concludes the paper.

2. Literature review

2.1. The impacts of competition and efficiency on risk in the banking industry

The competition-fragility hypothesis argues that banks can withstand shocks and decrease risk taking because in a less competitive environment they can earn higher profits through monopoly rents. In a pioneer investigation of the relationship between competition and stability in the banking sector, Keeley (1990) found that monopoly rents are eroded by an increase in competition, and this led to an increase in bank failures in the United States in the 1980s. Higher competition increases the number of marginal loan applicants who receive financing, so the quality of the loan portfolio is more likely to deteriorate and bank fragility increases. The competition-stability view suggests that in a less competitive banking market, banks charge higher interest rates, which will increase the probability of default on loan repayments (Boyd & De Nicole, 2005).

There are two main hypotheses about the impact of efficiency on risk in the banking industry, the bad management hypothesis and the moral hazard hypothesis. The bad management hypothesis (Berger & DeYoung, 1997; Williams, 2004) states that lower efficiency raises costs because banks do not monitor credit adequately and do not control expenses efficiently. The result is increases in banks' risk because of credit, operational, market, and reputational problems. The moral hazard hypothesis (Jeitschko & Jeung, 2005) suggests that managers of inefficient banks tend to take higher risks because of informational friction and agency problems.

2.2. The impacts of risk and efficiency on competition in the banking industry

A few empirical studies have investigated the impact of risk on competition (market power) in the banking industry (Fernández de Guevara & Maudos, 2007; Kasman & Carvallo, 2014; Tan & Floros, 2014). Most papers focus on either credit risk or insolvency risk. The impact of efficiency on competition is mainly addressed in the efficient-structure hypothesis (Demsetz, 1973) that more efficient banks gain market share at the expense of less efficient banks, so concentration increases and competition declines.

2.3. The impacts of competition and risk on efficiency in the banking industry

The competition-inefficiency hypothesis suggests that competition reduces bank efficiency, for the following reasons. First, Boot and Schmeits (2005) argue that higher bank competition increases customers' propensity to switch to other service providers, in turn amplifying information asymmetries and requiring banks to devote additional resources to screening and monitoring borrowers. Second, Chan and colleagues (1986) argue that in a competitive environment, where bank relationships have shorter duration, the reduction of relationship-building activities inhibits the reusability and value of information. In contrast, the competition-efficiency hypothesis maintains that higher competition induces banks to specialize in certain types of loans or particular groups of borrowers, and induces bank managers to adjust their lending technologies so as to lower the costs of processing and originating loans and to better monitor borrowers. This positive impact is the obverse of the "Quiet Life hypothesis," which argues that managers with monopoly power enjoy a share of monopoly rents, so they are careless in expense management and efficiency declines. The bad luck hypothesis (Berger & DeYoung, 1997) states that an increase in problem loans is mainly attributable to external events rather than managers' skills or their appetite for risk, and that the higher risk increases costs and managerial efforts. Thus, an increase in risk precedes a decline in bank efficiency.

2.4. The interrelationships among risk, competition, and efficiency in the banking industry

There are very few empirical studies testing the interrelationships among risk, competition, and efficiency in the banking sector. Using a sample of investment banks in ten large developed countries over the period 2000–2008, Fiordelisi, Girardone, and Nemanja (2011) examine Granger causality among these variables and show that the competition-stability paradigm holds for the investment banking industry. They find that competition in investment banking worldwide is quite limited, and that although relatively low competitive pressures enhance banks' stability, they also allow banks to undertake higher risks.

Kasman and Carrallo (2014) apply a similar approach to a sample of 272 commercial banks from 15 Latin American countries for the period 2001–2008. The results show that higher competition leads to greater financial stability, that banks with higher stability enjoy higher market power, and that banks with higher market power have higher efficiency.

3. Data description, institutional background, and research method

3.1. Data description

We use recent data from 100 Chinese commercial banks (5 SOCBs, 12 JSCBs, and 83 CCBs) for the period 2003–2013. The bank-specific data are collected from the

Bankscope database, while the industry-specific variables as well as macroeconomic variables are retrieved from CBRC and World Bank databases. Panel A of Table 1 presents the summary statistics of the variables that are used for the whole sample, while panels B, C, and D present the summary statistics of all variables by ownership types.

<<Table 1 about here>>

Figures 2a, 2b, 2c, and 2d report the risk conditions of Chinese banks over the period 2003–2013. Figure 2a shows that the credit risk of SOCBs is substantially higher than that of JSCBs and CCBs between 2003 and 2008. Although after 2008 the three types of banks differ little in credit risk, the credit risk of CCBs is higher than that of JSCBs between 2005 and 2010. Figure 2b shows that in general, the ratio of liquid assets to total assets for SOCBs is lower than that of JSCBs and CCBs; in other words, the SOCBs have the highest liquidity risk. However, liquidity is highest in CCBs from 2005 to 2008 and in JSCBs after 2010. In general, the capital level of CCBs kept increasing for most of the years examined, with slight decreases in some years (Figure 2c). The capital level of SOCBs and JSCBs increased in 2010 compared to the previous year. Figure 2d shows insolvency risk year by year, as measured by stability inefficiency. Risk conditions from 2003 to 2006 were highly volatile, but they became less so between 2007 and 2013.[2]

[2] For the estimation of insolvency risk, we follow Tan (2016) by estimating stability inefficiency derived from a translog specification with Z-score as the dependent variable. Four outputs (total loans, total deposits, other earning assets, and noninterest income) and two input prices (price of funds and price of capital) are considered.

Figure 3 shows that SOCBs have the highest technical efficiency over the period examined, while JSCBs have the lowest. When we decompose technical efficiency into pure technical efficiency and scale efficiency, SOCBs still have the highest pure technical efficiency, while CCBs have the lowest. Scale efficiency is higher than pure technical efficiency, indicating that scale efficiency contributes more than pure technical efficiency to overall technical efficiency in the Chinese banking sector. The results also suggest that Chinese commercial banks are inefficient in the pure technical sense and misallocate inputs and outputs in banking operations.[3]

The efficiency-adjusted Lerner index presented in Figure 4 suggests that city commercial banks have higher market power than joint-stock commercial banks and state-owned commercial banks over the period 2003–2008. In other words, competition is lowest among city commercial banks.[4]

<<Figure 2 about here>>

<<Figure 3 about here>>

<<Figure 4 about here>>

3.2. Institutional background

China's banking system has undergone several rounds of reforms, the purpose of which is to improve bank stability, increase competition, and improve the competitive power and performance of Chinese commercial banks. In order to enhance the stability

[3] For the estimation of efficiency of Chinese commercial banks, please see Appendix A for more details.

[4] For the estimation of the efficiency-adjusted Lerner index, please see Appendix B for more details.

of the industry, in 2003 the government established the China Banking Regulatory Commission (CBRC), which is mainly responsible for supervising commercial bank operations; formulating rules and regulations; authorizing the establishment, changes, termination, and business scope of banking institutions; and conducting on-site examination and off-site surveillance of bank operations (see Tan, 2016). In addition, the Chinese government significantly reduced the risk of Chinese commercial banks through writing off the loans in default of SOCBs by using four asset management companies. There were two waves of writeoffs, in 2004 and 2005.

To increase competition, the Chinese government and the banking regulatory authority introduced foreign banks and gradually released the restrictions on their activities. From 2001, foreign banks were allowed to provide foreign currency services to Chinese and foreign enterprises and individuals all over the country. At first they were allowed to offer local currency business to foreign enterprises and overseas individuals only in specific cities/areas in China, but this restriction was gradually released; also, foreign banks were allowed to provide local currency business to domestic Chinese enterprises as well as to Chinese individuals. By the end of 2006, foreign banks were treated exactly the same as domestic Chinese commercial banks, significantly improving competition in the industry.

To increase the competitive power of Chinese commercial banks, the Chinese government injected capital into SOCBs and JSCBs. In 2003, 42.5 billion USD was injected into the Bank of China and the China Construction Bank; in 2004, 15 billion USD was injected into the Industrial and Commercial Bank of China and 2.5 billion RMB into the Bank of Communication. In 2005 and 2006, 30 billion RMB was injected into the China Everbright bank, and finally, in 2008, the Agricultural Bank of China received 130 billion RMB.

In order to improve their performance, Chinese commercial banks started courting foreign strategic investors. By the end of 2003, 5 Chinese commercial banks had attracted 7 foreign strategic investors. In 2004, HSBC purchased a 19.9% share from the Bank of Communication, the largest foreign bank purchase of domestic bank shares at that time, and only 0.1% below the maximum percentage of shareholding by foreign strategic investors allowed by the CBRC. In 2004 and 2005, the number of foreign strategic investors kept increasing, until there were nearly 20 of them in 14 Chinese commercial banks. This number further increased to 33 foreign strategic investors in 25 domestic commercial banks by the end of 2007. By the end of 2011, the total number of foreign investors was 57 and the number of domestic commercial banks involved was 36.

3.3. Research methods

3.3.1. Measurement of competition in the Chinese banking industry—the efficiency-adjusted Lerner index

Recent empirical studies of bank competition use three main methods to measure competition: Panzar-Rosse H statistics (Jeon et al., 2011; Matthews et al., 2007; Olivero et al., 2011); the Boone indicator (Tabak et al., 2012; Tan, 2017), and the Lerner index (Cipollini & Fiordelisi, 2011; Fungacova et al., 2014; Tan, 2016).

The Panzar-Rosse H statistic suffers from two drawbacks. First, Leuvensteijn and colleagues (2011) argue that it is based on a static model and the value of the statistic ranges from $-\infty$ to 1. In other words, this indicator suffers from a degree of uncertainty.

Second, market entry and exit make it impossible to fulfil the test requirement of market equilibrium. The Boone indicator also suffers from two limitations: it assumes that part of banks' efficiency gains will be passed on to consumers (Tabak et al., 2012), and it, too, suffers from a degree of uncertainty derived from idiosyncratic variation.

We prefer the Lerner index as a measure of bank competition, mainly for two reasons. (1) It can be measured for each bank in each year, so it can be matched with other bank-specific variables and in particular with the key variables of the current study, efficiency and risk. (2) It can measure market power for all three types of Chinese commercial banks (SOCBs, JSCBs, and CCBs).

Koetter and colleagues (2012) argue that the conventional Lerner index assumes both profit efficiency and cost efficiency, and the estimated profit-cost margin does not accurately reflect the true market power. Therefore we use the efficiency-adjusted Lerner index proposed by Clerides and colleagues (2015). In the efficiency-adjusted Lerner index, the marginal cost is estimated using a translog cost function with four outputs (total deposits, total loans, noninterest income, and other earning assets) and two input prices (price of funds and price of capital).

3.3.2. Investigation of the interrelationships among competition, risk, and efficiency in the Chinese banking industry

We use a Granger-causality test, an approach that has been widely applied to test interrelationships in banking studies (Casu & Girardone, 2009; Fiordelisi, Marques-Ibanez, & Molyneux, 2011; Fiordelisi & Molyneux, 2010). The interrelationships among risk, competition, and efficiency in the Chinese banking industry can be estimated using the following equations:

$$Risk_{i,t} = f(Risk_{i,lag}, TEff_{i,lag}, PTEff_{i,lag}, SEff_{i,lag}, competition_{i,lag}, X_{i,t}) + \varepsilon_{i,t} \quad (1)$$

$$TEff_{i,t} = f(Risk_{i,lag}, TEff_{i,lag}, PTEff_{i,lag}, SEff_{i,lag}, competition_{i,lag}, X_{i,t}) + \varepsilon_{i,t} \quad (2)$$

$$PTEff_{i,t} = f(Risk_{i,lag,} TEff_{i,lag}, PTEff_{i,lag}, +SEff_{i,lag}, competition_{i,lag}, X_{i,t}) + \varepsilon_{i,t} \quad (3)$$

$$SEff_{i,t} = f(Risk_{i,lag,} TEff_{i,lag}, PTEff_{i,lag}, +SEff_{i,lag}, competition_{i,lag}, X_{i,t}) + \varepsilon_{i,t} \quad (4)$$

$$Competition_{i,t} = f(Risk_{i,lag,} TEff_{i,lag}, PTEff_{i,lag}, +SEff_{i,lag}, compeittion_{i,lag}, X_{i,t}) + \varepsilon_{i,t}.$$
(5)

The subscripts i and t represent a specific bank operating in a specific year, while Risk is the different types of risk considered in the current study: credit risk, liquidity risk, capital risk, and insolvency risk. We use relevant accounting ratios to measure the former three types of risk. Credit risk is measured by the ratio of nonperforming loans to total loans; a higher ratio indicates higher credit risk. Liquidity risk is measured by the ratio of liquid assets to total assets; here, a higher ratio indicates a lower liquidity risk. Capital risk is measured by the ratio of a bank's capital to its risk-weighted assets; a higher ratio indicates lower capital risk. For insolvency risk, rather than the accounting ratio (the Z-score[5]), we use a translog specification to estimate stability

[5] The Z-score reflects the extent to which banks can absorb losses. Thus, a higher Z-score indicates lower risk and greater stability. Most empirical studies use the Z-score to measure the stability of financial institutions (Iannotta et al., 2007). The Z-score is calculated as follows:

$$Z = \frac{ROA + E/A}{\sigma(ROA)}, \quad (6)$$

where ROA is banks' return on assets, E/A is the ratio of equity to total assets, and $\sigma(ROA)$ is the standard deviation of return on assets.

inefficiency (Tan, 2016) which is supposed to provide more robust results. TEff, PTEff, and SEff represent technical efficiency, pure technical efficiency, and scale efficiency, respectively. We measure efficiency by using Data Envelopment Analysis (DEA), following Chortareas and colleagues (2016); and rather than focusing on cost efficiency, we evaluate pure technical efficiency and scale efficiency. This estimation should help the Chinese government and banking regulatory authorities to find the source of inefficiency and make relevant policies to improve performance.

This is the first study applying the efficiency-adjusted Lerner index to measure competition and testing its interrelationships with risk and efficiency. The efficiency-adjusted Lerner index yields more robust results than the traditional Lerner index used by Fiordelisi, Girardone, and Nemanja (2011). In equations 1–5, X represents a number of control variables influencing the interrelationships among risk, efficiency, and competition: bank size, measured by the natural logarithm of total assets; diversification, measured by the ratio of noninterest income to gross revenue; bank profitability (ROA); banking sector development, measured by the ratio of banking sector assets to GDP; stock market development, measured by the ratio of market capitalization of listed companies to GDP; inflation; and GDP growth rate. Two ownership types are considered, joint-stock commercial banks (JSCBs) and city commercial banks (CCBs). ε is the error term.[6]

Given the frequency of our annual data, we follow the study of Fiordelisi, Marques-Ibanez, and Molyneux (2011) with regard to the choice of lag length. The

[6] Appendix C summarizes the variables used in the current study, while appendix D shows the total assets of categories of banking institutions in China in 2013 other than SOCBs, JSCBs, and CCBs.

AR(2) process is estimated for the interrelationships among risk, efficiency, and competition. Granger causality is assessed as the joint test of the null hypothesis that the two lags are equal to zero. With the AR(2) process, we analyse Granger causality as the joint test that the two lags of each of the determinants is distributed as a chi-square with two degrees of freedom. The null hypothesis, that two lags are equal to zero, will be rejected if the probability value is less than 10%. In other words, if the probability value is less than 0.1, at the 10% significance level, it can be concluded that x does have an impact on y. In estimating the above equations, we follow Fiordelisi, Marques-Ibanez, and Molyneux (2011) by calculating a two-step Generalized Method of Moments (GMM) system estimator with Windmeijer's (2005) corrected standard error.

4. Empirical results

In column 1 of Tables 2 and 5, the positive and significant coefficients of technical efficiency (Total), pure technical efficiency (Total), and scale efficiency (Total) show that efficiency is positively and significantly related to the credit risk and insolvency risk of Chinese commercial banks. The effect on credit risk, which contradicts the bad management and moral hazard hypotheses, can be interpreted as indicating that, in order to generate a higher volume of outputs, Chinese commercial banks put less effort into monitoring and credit-checking loans. This omission increases the volume of loans in default and thus credit risk. The effect on insolvency risk can be interpreted as indicating that Chinese commercial banks with greater efficiency engage in diversified portfolios of business; also, the large demand for funds reduces solvency and increases insolvency risk.

In Column 1 of Tables 3 and 4, the positive and significant coefficients of technical efficiency (Total), pure technical efficiency (Total), and scale efficiency (Total) show that higher efficiency leads to higher ratio of liquid assets to total assets (lower liquidity risk) and higher ratio of a bank's capital to its risk-weighted assets (lower capital risk). In other words, efficiency is significantly and negatively related to liquidity risk and capital risk. The effect on liquidity risk, which is in line with the bad management hypothesis, can be interpreted as indicating that Chinese commercial banks with higher levels of efficiency have higher ability to generate higher volumes of outputs using a certain amount of inputs, or minimize the input investment to produce certain levels of outputs, thus reducing the bank's cost and improving its profitability. In turn, higher profitability allows banks to retain higher volumes of capital, so they have lower capital risk.

The efficiency-adjusted Lerner index is positively and significantly related to credit risk and insolvency risk, in line with the competition-stability hypothesis, while it is negatively related to liquidity risk, in accordance with the competition-fragility hypothesis (see column 1 of Tables 2, 3, and 5).

Further, we find that credit risk and insolvency risk are positively and significantly related to efficiency. The effect of credit risk (see columns 3 and 4 of Table 2), which contradicts the bad luck hypothesis, can be interpreted as indicating that higher volumes of loans in default drive bank managers to put more effort into allocating resources and thereby improve efficiency. The effect of insolvency risk (see columns 2–4 in Table 5) can be interpreted as indicating that Chinese commercial banks use all available funds to engage in different types of business (traditional loan and deposit business as well as other noninterest income-generating business), so it is difficult for the banks to meet their obligations when they become due. However, the large volumes and large variety of business also generate economies of scale as well as economies of scope that improve efficiency.

The results further show that liquidity risk and capital risk have negative and significant impacts on the efficiency of Chinese commercial banks. The positive and significant coefficients for liquidity risk (see columns 2 and 3 in Table 3) may indicate that banks with higher liquidity have stronger ability to deal with sudden withdrawals by depositors, to some extent reflecting good management. Higher managerial ability improves the allocation of inputs and outputs, and thereby improves efficiency. The negative and significant impact of capital risk on efficiency (see columns 2–4 in Table 4) is in line with the findings of Fiordelisi, Marques-Ibanez, and Molyneux (2011) for a sample of European banks. This result can be interpreted as indicating that banks with more capital (lower capital risk) have lower funding costs, as higher capital is an important signal of creditworthiness (Molyneux, 1993). In turn, lower funding cost reduces input investment and improves efficiency.

Finally, column 5 in Table 3 shows that lower liquidity risk results in a less competitive environment (higher market power). Banks with lower liquidity risk have lower borrowing costs, and the resulting improvement in price and cost margin increases market power.

<<Table 2 about here>

<<Table 3 about here>>

<<Table 4 about here>>

<<Table 5 about here>>

5. Robustness check

We tested the robustness of our empirical results in a number of ways. First, we used alternative econometric techniques: the three-stage least square estimator (3-SLS) as well as the seemingly unrelated regression (SUR). Second, we used the Lerner index, rather than the efficiency-adjusted Lerner index. Finally, we used the Z-score as an alternative indicator of insolvency risk. All these tests confirm that our main results hold.[7]

6. Summary and concluding remarks

For our sample of Chinese commercial banks over the period 2003–2013, higher efficiency leads to higher credit risk and insolvency risk, but lower liquidity risk and capital risk. Chinese commercial banks undertake higher credit risk and insolvency risk, and lower liquidity risk, in a less competitive environment. Credit risk and insolvency risk seem to increase bank efficiency, while liquidity risk and capital risk significantly decrease it. Finally, lower liquidity risk increases market power (decreases competition) for Chinese commercial banks. We strongly believe that our study not only provides a comprehensive picture of the risk conditions of Chinese commercial banks, but also sheds light on the interrelationships among risk, efficiency, and competition in general, and provides insights relevant to banking research in other countries.

Our findings have important policy implications. First, the Chinese government and regulatory authorities should increase the levels of capital held by Chinese commercial banks; the capital injections already made have been very effective in

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[7] The results of the robustness check are not reported in this paper to save space; they are available from the authors upon request.

reducing capital risk and improving efficiency. Second, the government should continue its effort to increase competition, as greater competition reduces the volume of loans in default. Finally, both commercial banks and regulatory authorities should carefully consider liquidity levels to balance increased competition with decreased efficiency.

Appendix A

Efficiency estimation of bank efficiency using data envelopment analysis (DEA)

The efficiency estimates in this study are obtained using DEA, following Sufian (2010). Both DEA CCR and DEA BCC models are used to derive the technical, pure technical, and scale efficiencies of Chinese commercial banks. The CCR model can be expressed as follows:

$$\min_{\theta,\lambda} \theta, subjectto - y_i + Y\lambda \geq 0, \theta X_i - X\lambda \geq 0, \lambda \geq 0 \quad , \qquad \text{(A.1)}$$

where θ is a scalar and λ is a N×1 vector of constants, Y represents all input and output data for N firms, x_i are individual inputs, and y_i is the outputs for the i th firm. The efficiency score for each DMU is given by θ; it takes a value between 0 and 1, which indicates the efficiency level.

The CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint, N1'λ=1, to produce

$$\min_{\theta,\lambda} \theta, subjectto - y_i + Y\lambda \geq 0, \theta X_i - X\lambda \geq 0, N1'\lambda = 1, \lambda \geq 0 \; , \qquad \text{(A.2)}$$

where N1 is an N×1 vector of ones. This approach forms a convex hull of intersecting plans that envelop the data points more tightly than the CRS conical hull; this provides pure technical efficiency scores which are greater than or equal to those obtained using the CRS model. If the efficiency scores obtained from the CRS model and the VRS model are different, this indicates that the DMU has scale inefficiency, and that the scale inefficiency can be calculated from the difference between the VRS technical efficiency (TE) score and the CRS TE score. The relationship between CRS and VRS is given below:

$$TE_{CRS} = TE_{VRS} \times SE \ . \qquad \text{(A.3)}$$

The main argument for preferring DEA to parametric techniques, such as SFA, lies in the fact that it works particularly well with small samples. Furthermore, it is able to handle multiple inputs and outputs stated in different measurement units, and it does not necessitate knowledge of any functional form of the frontier (Charnes et al., 1995). Most empirical papers show that using DEA to estimate the efficient frontier can yield robust results (Seiford & Thrall, 1990). We use two inputs, the price of deposit (measured by the ratio of interest expenses to total deposits), and the price of capital (measured by the ratio of noninterest expenses to fixed assets). Two input prices are considered because noninterest expenses include labor cost as well (Hasan & Morton, 2003). In other words, the price of capital considers factors relating to the price of human capital as well as the price of physical capital . Four outputs are selected in the current study: total loans, securities, noninterest income, and total deposits.

Appendix B

Estimation of competition in the banking industry: the efficiency-adjusted Lerner index

We follow Clerides and colleagues (2015) with regard to the estimation of the efficiency-adjusted Lerner index, which can be expressed as follows:

$$efficiency adjusted Lerner index_{it} = \frac{\pi_{it} + tc_{it} - mc_{it} * q_{it}}{\pi_{it} + tc_{it}}, \qquad (B.1)$$

where i and t represent a specific bank operating in a specific year; π represents bank profit, measured by net income; tc represents total cost, calculated as the sum of interest expenses as well as noninterest expenses; and q stands for earning assets. We use total loans and total securities as the measurement of earning assets. mc stands for marginal cost, which is calculated by using a translog cost function as follows:

$$LN(\frac{C}{W_2})_{it} = \delta_0 + \sum_j \delta_j LNY_{jit} + \frac{1}{2}\sum_j \sum_k \delta_{jk} LNY_{jit} LNY_{kit} + \beta_1 LN(\frac{W_1}{W_2})_{it} + \frac{1}{2}\beta_{11} LN(\frac{W_1}{W_2})_{it} LN(\frac{W_1}{W_2})_{it} + \sum_j \theta_j LNY_{jit} LN(\frac{W_1}{W_2})_{it} + \varepsilon_{it}. \qquad (B.2)$$

where C represents the bank's total cost; Y represents total deposits, total loans, noninterest income, and other earning assets; and W stands for two input prices, with W_1 representing the price of funds, measured by the ratio of interest expenses to total deposits, and W_2 representing the price of capital, measured by the ratio of noninterest expenses to fixed assets. Two input prices are considered, since noninterest expenses includes labor cost (Hasan & Morton, 2003). In other words, the price of capital considers the price of human capital as well as the price of physical capital. Linear homogeneity is ensured by normalizing the dependent variable and W_1 by another input price W_2.

The marginal cost of loans can be obtained by taking the first derivative of the dependent variable in the above equation in relationship to the output loans, as follows:

$$MC_{ilt} = (\frac{C_{it}/W_2}{Y_{ilt}})(\delta_{j=l} + 2\delta_{ll} LNY_{ilt} + \sum_{k-1\ldots k, k\neq l} \delta_{lk} LNY_{ikt} + \theta_l LN(\frac{W_1}{W_2})) \ . \qquad (B.3)$$

Appendix C

Variable descriptions

Variable	Symbol	Description
Risk	Credit risk Liquidity risk Capital risk Insolvency risk	Ratio of loans in default to total loans Ratio of liquid assets to total assets Ratio of a bank's capital to its risk-weighted assets Estimate from stochastic frontier
Efficiency	TEff PTEff SEff	Estimate from data envelopment analysis
Competition	Efficiency-adjusted Lerner index	See Appendix B
Bank size	LTA	Natural logarithm of total assets
Bank diversification	NNIGR	Ratio of noninterest income to gross revenue
Bank profitability	ROA	Ratio of net income to total assets
Banking sector development	BSD	Ratio of banking sector assets to GDP
Stock market development	SMD	Ratio of market capitalization of listed companies to GDP
Inflation	INF	Annual inflation rate
GDP growth rate	GDPG	Annual GDP growth rate

Appendix D

Total assets of categories of banking institutions in China in 2013 other than SOCBs, JSCBs, and CCBs

Institution	Total assets
Policy banks and the China Development Bank	125278
Rural commercial banks	85218
Rural cooperative banks	12322
Rural credit cooperatives	85951
Nonbank financial institutions	39681
Foreign banks	25628
New-type rural financial institutions and the postal savings bank	62110

Notes: figures in RMB100 million.

Data source: 2013 Annual report of the China Banking Regulatory Commission (CBRC).

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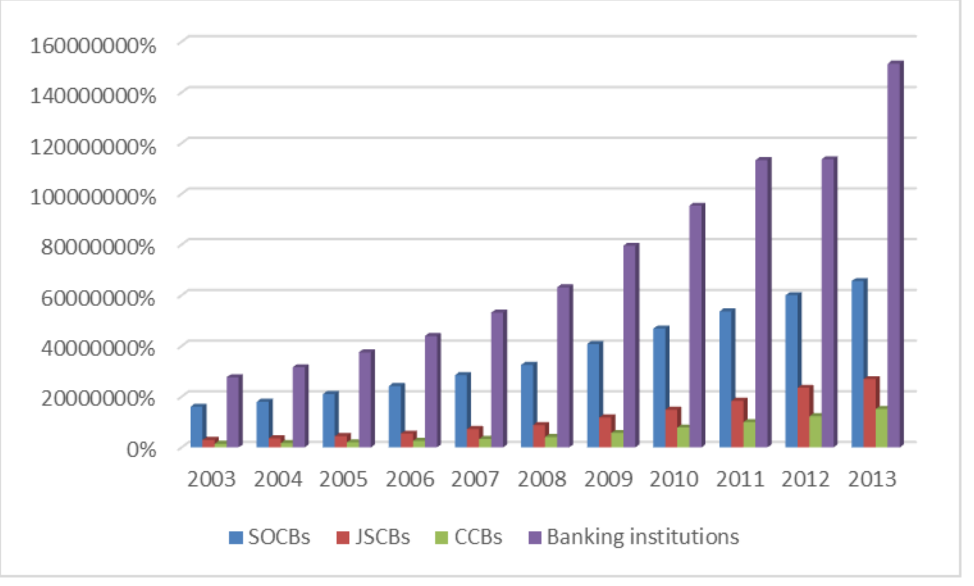

Fig. 1. Summary of the assets of SOCBs, JSCBs, CCBs and total banking institutions in China over the period 2003–2013.

Source: Annual reports of CBRC (China Banking Regulatory Commission); figures in RMB 100 million.

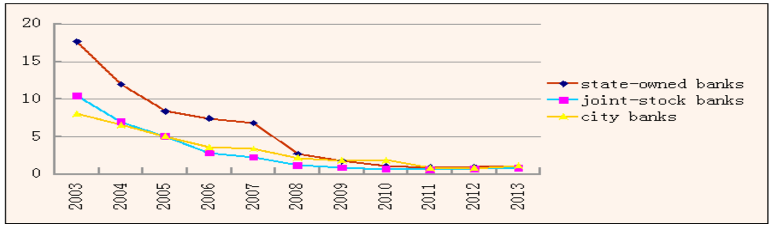

Fig. 2a. Credit risk in the Chinese banking industry.

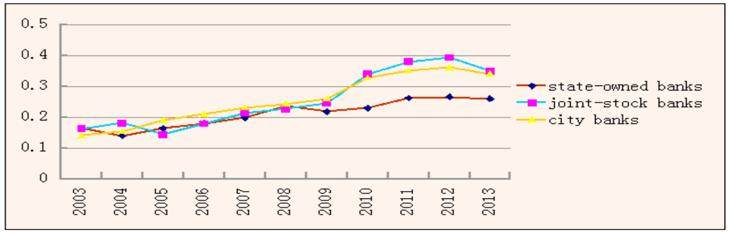

Fig. 2b. Liquidity risk in the Chinese banking industry.

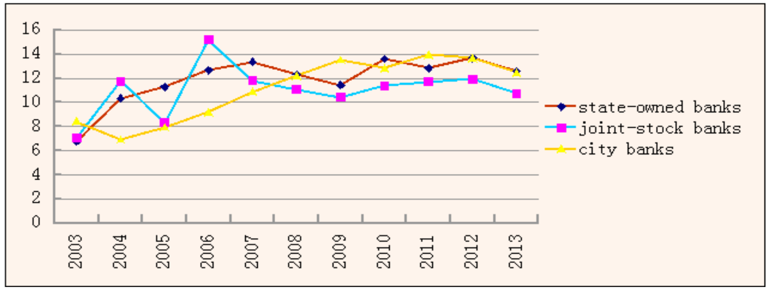

Fig. 2a. Capital risk in the Chinese banking industry.

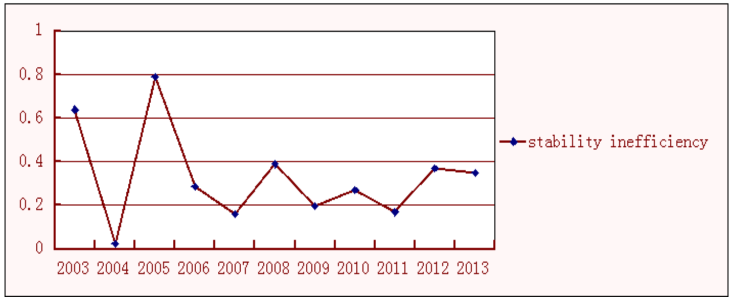

Fig. 2b. Insolvency risk (stability inefficiency) in the Chinese Banking industry.

Fig. 2. Risk conditions in the Chinese banking industry (2003–2013).

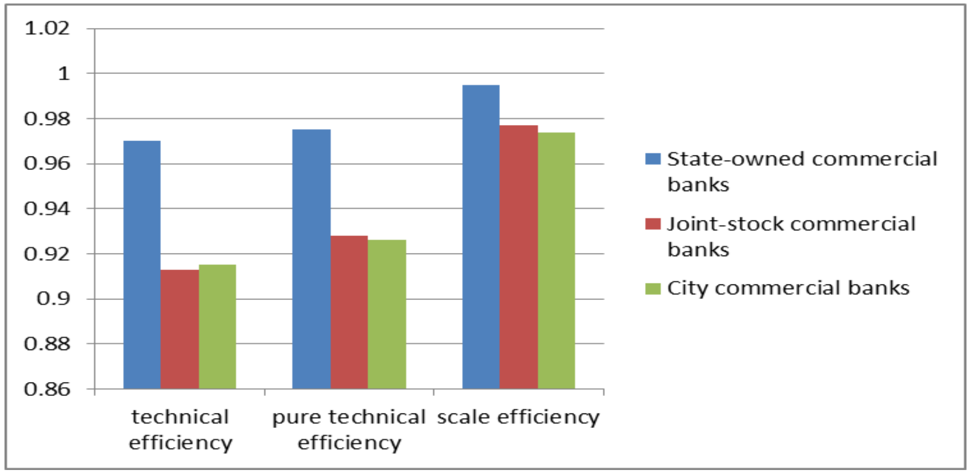

Fig. 3. Efficiency in the Chinese banking industry.

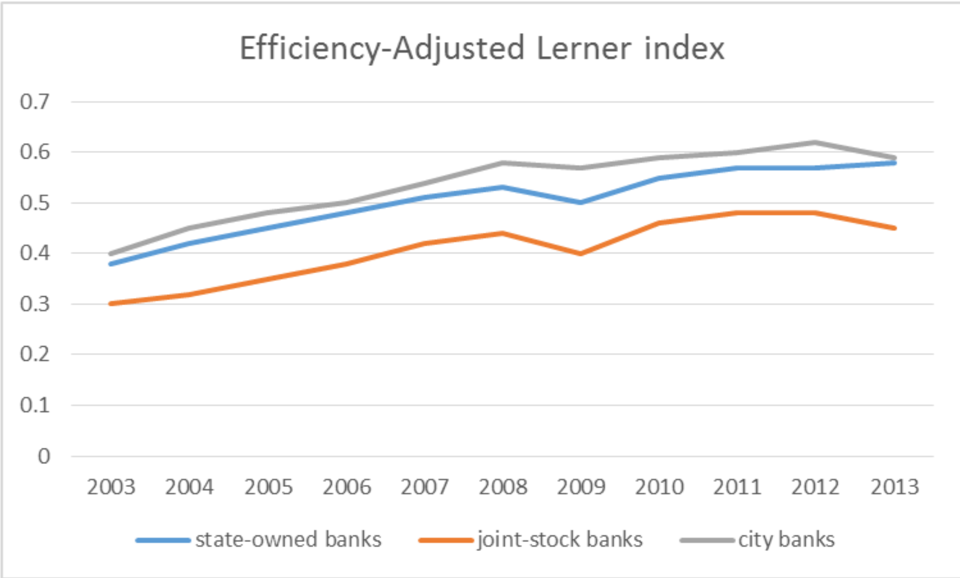

Fig. 4. Competitive conditions in the Chinese banking industry as measured by efficiency-adjusted Lerner index.

Table 1

Descriptive statistics of the variables.

	Panel A: all banks				Panel B: SOCBs				Panel C: JSCBs				Panel D: CCBs			
	Obs	Mean	SD	Median	Obs	Mean	SD	Median	Obs	Mean	SD	Median	Obs	Mean	SD	Median
Credit risk	632	2.78	4.48	2.17	56	5.8	8.16	5.5	96	2.37	3.96	2.33	480	2.51	3.8	2.42
Liquidity risk	777	0.27	0.12	0.21	56	0.21	0.052	0.19	110	0.278	0.105	0.25	611	0.27	0.12	0.25
Capital risk	637	11.9	4.7	10.38	50	11.83	2.02	11.77	101	11.24	6.09	11.18	486	12.06	4.56	11.19
Insolvency risk	1100	0.33	0.21	0.31	55	0.331	0.212	0.32	132	0.331	0.21	0.31	913	0.331	0.21	0.28
Technical efficiency	751	0.92	0.059	0.88	55	0.97	0.035	0.81	132	0.913	0.05	0.89	564	0.92	0.06	0.77
Pure technical efficiency	759	0.93	0.055	0.9	55	0.975	0.033	0.93	133	0.928	0.05	0.91	571	0.926	0.06	0.83
Scale efficiency	759	0.976	0.102	0.95	55	0.995	0.006	0.98	133	0.977	0.087	0.95	571	0.974	0.11	0.96
Efficiency-adjusted Lerner index	800	0.53	0.13	0.48	56	0.487	0.09	0.45	129	0.495	0.1	0.45	615	0.54	0.13	0.49
Size	843	4.9	0.99	4.5	56	6.77	0.32	6.55	136	5.76	0.55	5.58	651	4.56	0.798	4.49
Bank diversification	828	13.98	13.31	13.88	56	17.5	7.82	16.9	134	12.13	7.87	12.08	638	14.06	14.5	13.88
ROA	808	0.008	0.006	0.006	55	0.009	0.004	0.007	127	0.006	0.006	0.005	598	0.01	0.007	0.008
Banking sector development	1100	2.22	0.24	0.21												
Stock market development	1027	71.2	43.39	69.2												
Inflation	1128	2.85	1.93	2.55												
GDP growth	1100	10.19	1.87	10.03												

Table 2

Relationship among credit risk, efficiency, and competition in the Chinese banking industry.

	Model 1: y=credit risk (Column 1)	Model 2: y=technical efficiency (Column 2)	Model 3: y=pure technical efficiency (Column 3)	Model 4: y=scale efficiency (Column 4)	Model 5: y=efficiency-adjusted Lerner index (Column 5)
Intercept	129.87(1.62)	119.14*(1.66)	69.77**(1.98)	4.29**(2.07)	24.21(1.50)
Credit Risk (t-1)	0.25***(5.11)	0.001(0.35)	0.001(0.55)	0.001***(3.07)	-0.001(-1.19)
Credit risk (t-2)	0.09***(2.91)	0.001(0.88)	0.001(1.55)	0.0001(0.08)	-0.0004(-0.73)
Credit risk (total)	91.25***	2.24	5.26*	15.48***	2.61
Technical efficiency(t-1)	-281.37***(-4.23)	138.74*(1.81)	81.13**(2.18)	6.74***(3.19)	28.11(1.53)
Technical efficiency (t-2)	447.51***(4.22)	-6.47(-0.46)	-3.68(-0.49)	-2.9***(-3.42)	-1.71(-0.25)
Technical efficiency (total)	23.02***	3.74	5.58*	21.97***	2.38
Pure technical efficiency (t-1)	268.32***(4.10)	-137.6*(-1.81)	-80.53**(-2.18)	-6.83***(-3.27)	-27.72(-1.53)
Pure technical efficiency (t-2)	-438.9***(-4.14)	6.66(0.48)	3.76(0.51)	2.9***(3.44)	1.8(0.26)
Pure technical efficiency (total)	21.83***	3.72	5.54*	22.50***	2.37
Scale efficiency (t-1)	273.97***(4.29)	-126.09*(-1.80)	-73.63**(-2.17)	-5.88***(-3.05)	-26.34(-1.55)
Scale efficiency(t-2)	-401.15***(4.18)	5.95(0.47)	3.4(0.50)	2.46***(3.21)	1.89(0.30)
Scale efficiency (total)	22.99***	3.72	5.54*	20.14***	2.42
Efficiency-adjusted Lerner index (t-1)	-1.76**(-2.31)	-0.02(-0.21)	-0.02(-0.35)	0.03***(3.19)	0.27***(3.64)
Efficiency-adjusted Lerner	-1.83*(1.90)	-0.04(-0.46)	-0.01(-0.18)	-0.02**(-2.00)	0.11***(3.29)

index (t-2)					
Efficiency-adjusted Lerner index (total)	5.56**	0.52	0.28	11.48***	20.52***
Bank size	0.16***(2.52)	0.02***(3.04)	0.02***(5.10)	0.005***(3.72)	-0.01*(-1.71)
Diversification	-0.01**(-2.31)	0.0004(0.72)	0.0004(1.01)	0.0002***(3.52)	-0.0002(-0.48)
ROA	-15.27***(-3.12)	0.72(1.44)	0.45(1.19)	0.03(0.35)	5.76***(11.75)
Banking sector development	-0.25(-0.49)	0.24***(4.12)	0.25***(6.86)	0.05***(5.13)	0.06(1.56)
Stock market development	-0.006***(-2.79)	0.0002(0.85)	-9.18e-06(-0.07)	-0.0001**(-2.21)	0.0004**(2.25)
Inflation	-0.03*(-1.75)	0.012***(3.91)	0.01***(5.61)	0.001***(3.58)	0.005***(3.45)
GDP growth rate	0.33***(5.06)	-0.001(-0.09)	0.006(1.39)	0.005***(3.88)	-0.004(-0.80)
JSCBs	-0.38***(-9.00)	-0.05***(-3.12)	-0.22***(-4.18)	-0.02***(-3.57)	0.05(0.80)
CCBs	0.74***(-11.91)	-0.06***(-3.55)	-0.38***(-4.32)	-0.03***(-3.92)	0.12***(6.19)
Observations	285	295	296	296	297
Hansen test	0.644	0.768	0.366	0.395	0.369
AR(1)	0.034	0.088	0.025	0.001	0.006
AR(2)	0.938	0.611	0.915	0.809	0.213

Notes: We use a two-step system GMM estimator.

The symbols *, **, ***, represent significance levels of 10%, 5%, and 1%, respectively.

The variables credit risk (total), technical efficiency (total), pure technical efficiency (total), efficiency-adjusted Lerner (total) are the estimated coefficients for the test that the sum of the lagged terms is equal to zero. A significance level lower than 10% enables us to reject the null hypothesis that x does not have an impact on y. A significant and positive sign indicates that the impact is positive, while a significant and negative sign indicates a negative impact. The null hypothesis of the Hansen test is that instruments used are not correlated with residuals, and so the overidentifying restrictions are valid. In AR (Arellano-Bond) tests for serial correlation in the first-differenced residuals, the null hypothesis is that errors in the first difference regression do not exhibit first/second order serial correlation.

Table 3

Relationship among liquidity risk, efficiency, and competition in the Chinese banking industry.

	Model 1: y=liquidity risk (Column 1)	**Model 2: y=technical efficiency (Column 2)**	**Model 3: y=pure technical efficiency (Column 3)**	**Model 4: y=scale efficiency (Column 4)**	**Model 5: y=efficiency-adjusted Lerner index (Column 5)**
Intercept	-8.27**(-2.22)	71.07*(1.93)	-13.56***(-4.50)	18.41***(11.62)	9.81(1.33)
Liquidity Risk (t-1)	0.3**(2.35)	-0.23***(-2.63)	-0.16***(-7.87)	0.007(0.55)	-0.06*(-1.67)
Liquidity risk (t-2)	0.2**(6.08)	0.02(0.19)	0.04**(1.96)	0.02(1.09)	0.07***(2.61)
Liquidity risk (total)	45.28***	10.09***	61.98***	1.56	7.18**
Technical efficiency(t-1)	-4.38(-0.92)	102.37**(2.05)	13.58***(3.16)	13.12***(10.48)	9.45(1.05)
Technical efficiency (t-2)	-3.93(-1.25)	-25.66(-1.63)	-28.7***(-8.48)	5.74***(3.82)	0.89(0.18)
Technical efficiency (total)	5.41*	4.23	82.33***	153.93***	1.83
Pure technical efficiency (t-1)	4.24(0.91)	-100.94**(-2.05)	-13.38***(3.15)	-13.17***(-10.70)	-9.25(-1.04)
Pure technical efficiency (t-2)	3.81(1.23)	25.47(1.62)	28.26***(8.39)	-5.61***(-3.79)	-0.87(-0.18)
Pure technical efficiency (total)	5.22*	4.22	80.53***	158.57***	1.85
Scale efficiency (t-1)	4.52(0.98)	-94.34**(-2.04)	-12.23***(-3.09)	-12.17***(-10.29)	-9.24(-1.09)
Scale efficiency(t-2)	3.44(1.14)	22.75(1.60)	26.2***(8.49)	-5.57***(-4.06)	-0.69(-0.15)
Scale efficiency (total)	5.31*	4.21	82.42***	146.5***	1.77
Efficiency-adjusted Lerner index (t-1)	0.24***(4.74)	0.04(0.92)	0.06***(3.22)	0.004(0.48)	0.44***(13.59)
Efficiency-adjusted Lerner	-0.06(-1.40)	-0.06(-0.76)	0.03(1.52)	-0.02(-1.36)	0.1***(4.55)

index (t-2)					
Efficiency-adjusted Lerner index (total)	25.49***	1.15	13.50***	2.06	321.54***
Bank size	0.003(0.94)	0.011(1.61)	0.02***(6.95)	0.008***(5.56)	-0.0002(-0.07)
Diversification	-0.00003(-0.10)	0.002***(3.08)	0.001***(5.30)	0.001***(4.83)	-0.00004(-0.17)
ROA	-0.6**(-2.00)	0.6(1.01)	0.23***(2.92)	-0.025(-0.31)	5.12***(10.02)
Banking sector development	0.21***(5.30)	0.14**(2.12)	0.23***(14.54)	0.045***(5.41)	0.04(1.59)
Stock market development	-0.0002*(-1.66)	0.0004(1.05)	-0.00005(-0.79)	-0.0002***(-5.13)	0.0004***(2.82)
Inflation	0.01***(5.50)	0.01***(3.73)	0.008***(11.19)	0.003***(8.37)	0.005***(5.02)
GDP growth rate	0.012***(3.17)	-0.01(-0.87)	0.007***(3.91)	0.008***(6.33)	-0.003(-0.83)
JSCBs	0.61***(4.18)	-0.06***(-3.52)	-0.18***(-3.29)	-0.09***(-5.11)	0.07(0.76)
CCBs	1.26***(4.94)	-0.08***(-3.95)	-0.22***(-3.55)	-0.12***(-6.280	0.22***(5.11)
Observations	371	359	361	361	362
Hansen test	0.405	0.357	0.274	0.218	0.631
AR(1)	0.011	0.056	0.000	0.110	0.001
AR(2)	0.656	0.438	0.241	0.759	0.300

Notes: We use a two-step system GMM estimator.

The symbols *, **, ***, represent significance levels of 10%, 5%, and 1%, respectively. The variables liquidity risk (total), technical efficiency (total), pure technical efficiency (total), and efficiency-adjusted Lerner index (total) are the estimated coefficients for the test that the sum of the lagged terms is equal to zero. A significance level lower than 10% enables us to reject the null hypothesis that x does not have an impact on y. A significant and positive sign indicates that the impact is positive, while a significant and negative sign indicates a negative impact. The null hypothesis of the Hansen test is that instruments used are not correlated with residuals, and so the overidentifying restrictions are valid. In AR (Arellano-Bond) tests for serial correlation in the first-differenced residuals, the null hypothesis is that errors in the first difference regression do not exhibit first/second order serial correlation.

Table 4

Relationship among capital risk, efficiency, and competition in the Chinese banking industry.

	Model 1: y=capital risk (Column 1)	Model 2: y=technical efficiency (Column 2)	Model 3: y=pure technical efficiency (Column 3)	Model 4: y=scale efficiency (Column 4)	Model 5: y=efficiency-adjusted Lerner index (Column 5)
Intercept	-172.72(-0.98)	-37.16***(-7.38)	-38.35***(-6.52)	-2.1(-0.56)	14.19(1.18)
Capital Risk (t-1)	0.47***(9.41)	0.002***(2.84)	0.002**(2.58)	0.001**(2.56)	0.0004(0.37)
Capital risk (t-2)	-0.06*(-1.91)	0.002***(3.55)	0.001**(2.44)	0.001***(2.81)	-0.002(-1.54)
Capital risk (total)	89.54***	19.86***	17.41***	19.51***	2.38
Technical efficiency(t-1)	274.81*(1.71)	2.55(0.67)	-2.23(-0.35)	1.68(0.90)	23.11*(1.67)
Technical efficiency (t-2)	-469.24***(-3.95)	-44.25***(-12.33)	-41.07***(-8.75)	-5.05*(-1.68)	-8.7(-1.51)
Technical efficiency (total)	17.37***	157.29***	89.01***	6.05**	3.80
Pure technical efficiency (t-1)	-273.25*(-1.72)	-2.27(-0.60)	2.23(0.35)	-1.82(-0.98)	-22.55*(-1.65)
Pure technical efficiency (t-2)	473.29***(4.00)	43.56***(12.23)	40.53***(8.69)	4.999*(1.68)	8.62(1.51)
Pure technical efficiency (total)	17.66***	154.55***	88.31***	6.40**	3.75
Scale efficiency (t-1)	-241.08(-1.60)	-1.97(-0.56)	2.12(0.36)	-1.35(-0.81)	-22.51*(-1.76)
Scale efficiency(t-2)	415.03***(3.85)	39.75***(12.57)	36.85***(8.75)	4.4(1.62)	8.12(1.54)
Scale efficiency (total)	16.46***	164.6***	88.74***	5.57*	4.16
Efficiency-adjusted Lerner index (t-1)	2.38*(1.75)	-0.03(-1.17)	-0.01(-0.42)	0.02*(1.75)	0.42***(5.28)
Efficiency-adjusted Lerner	0.14(0.10)	-0.03(-1.11)	-0.008(-0.51)	-0.02(-1.50)	0.096***(2.64)

index (t-2)					
Efficiency-adjusted Lerner index (total)	3.09	5.46*	0.94	4.94*	47.51***
Bank size	-0.22**(-2.34)	0.02***(7.43)	0.02***(6.35)	0.005***(2.82)	-0.009*(-1.85)
Diversification	-0.02*(-1.86)	0.001***(6.20)	0.001***(6.12)	0.0003***(3.62)	0.0001(0.24)
ROA	1.69(0.10)	-0.22*(-1.70)	0.05(0.39)	-0.21**(-2.37)	6.13***(20.51)
Banking sector development	0.59(0.67)	0.21***(13.41)	0.24***(12.15)	0.05***(5.42)	0.02(0.73)
Stock market development	0.0004(0.10)	0.0001(1.60)	-0.0001(-1.53)	-0.0001***(-2.66)	0.0005***(3.82)
Inflation	0.11**(2.32)	0.008***(16.80)	0.008***(11.35)	0.001***(2.69)	0.004***(3.55)
GDP growth rate	-0.07(-0.59)	0.005***(2.93)	0.01***(4.67)	0.006***(4.96)	-0.01*(-1.85)
JSCBs	0.004(0.12)	-0.05***(-4.14)	-0.15***(-4.17)	-0.04***(-3.79)	0.12(0.03)
CCBs	0.41***(5.88)	-0.07***(-3.98)	-0.38***(-4.22)	-0.06***(-4.11)	0.02***(3.18)
Observations	269	287	288	288	290
Hansen test	0.245	0.145	0.174	0.175	0.631
AR(1)	0.003	0.006	0.011	0.000	0.022
AR(2)	0.327	0.993	0.824	0.510	0.443

Notes: We use a two-step system GMM estimator.

The symbols *, **, ***, represent significance levels of 10%, 5%, and 1%, respectively. The variables capital risk (total), technical efficiency (total), pure technical efficiency (total), and efficiency-adjusted Lerner index (total) are the estimated coefficients for the test that the sum of the lagged terms is equal to zero. A significance level lower than 10% enables us to reject the null hypothesis that x does not have an impact on y. A significant and positive sign indicates that the impact is positive, while a significant and negative sign indicates a negative impact. The null hypothesis of the Hansen test is that instruments used are not correlated with residuals, and so the overidentifying restrictions are valid. In AR (Arellano-Bond) tests for serial correlation in the first-differenced residuals, the null hypothesis is that errors in the first difference regression do not exhibit first/second order serial correlation.

Table 5

Relationship among insolvency risk, efficiency, and competition in the Chinese banking industry.

	Model 1: y=insolvency risk (Column 1)	Model 2: y=technical efficiency (Column 2)	Model 3: y=pure technical efficiency (Column 3)	Model 4: y=scale efficiency (Column 4)	Model 5: y=efficiency-adjusted Lerner index (Column 5)
Intercept	5.74(0.35)	29.93(0.57)	-41.53**(-2.47)	1.2(0.49)	-1.35(-0.58)
Insolvency Risk (t-1)	-0.67***(-23.89)	0.03**(2.09)	0.04***(3.38)	0.01***(2.96)	-0.01(-1.09)
Insolvency risk (total)	570.91***	4.36**	11.43***	8.76***	1.20
Technical efficiency(t-1)	-23.87(-1.31)	54.75*(1.83)	3.7(0.53)	-0.82(-0.38)	-2.79(-0.83)
Technical efficiency (t-2)	32.1**(2.55)	-22.62(-0.70)	-48.71***(-3.15)	1.58(0.81)	1.47(0.43)
Technical efficiency (total)	6.66****	9.14**	11.77***	0.69	0.76
Pure technical efficiency (t-1)	22.6(1.25)	-54.02*(-1.83)	-3.71(-0.54)	0.66(0.32)	2.69(0.81)
Pure technical efficiency (t-2)	-30.83**(-2.47)	22.29(0.69)	47.94***(3.13)	-1.56(-0.82)	-1.44(-0.43)
Pure technical efficiency (total)	6.22**	9.07**	11.63***	0.68	0.73
Scale efficiency (t-1)	21.97(1.29)	-49.97*(-1.79)	-2.61(-0.40)	1.32(0.64)	2.43(0.76)
Scale efficiency(t-2)	-26.45**(-2.31)	20.1(0.67)	44.94***(3.22)	-1.55(-0.81)	-1.06(-0.33)
Scale efficiency (total)	5.58*	9.11**	12.20***	0.88	0.70
Efficiency-adjusted Lerner index (t-1)	-0.23(-1.31)	-0.003(-0.07)	0.002(0.07)	0.02*(1.80)	0.5***(15.46)
Efficiency-adjusted Lerner index (t-2)	0.54***(3.75)	-0.09*(-1.80)	-0.03(-0.82)	-0.006(-0.46)	0.08***(2.84)

Efficiency-adjusted Lerner index (total)	14.17***	3.80	0.76	3.27	355.98***
Bank size	-0.05***(-2.59)	0.014***(3.49)	0.02***(3.53)	0.003**(2.40)	0.001(0.39)
Diversification	0.002*(1.94)	0.001***(3.35)	0.001**(2.26)	0.0004***(2.91)	-0.0001(-0.50)
ROA	-39.23***(-2.86)	0.44(1.38)	0.48***(2.90)	0.008(0.08)	4.33***(7.16)
Banking sector development	-0.07(-1.01)	0.18**(2.15)	0.29***(9.34)	0.03**(2.28)	0.08***(3.77)
Stock market development	-0.002***(-5.87)	0.0002(1.01)	-7.92E-06(-0.08)	-0.0001**(-2.22)	0.0002***(2.89)
Inflation	-0.01(-1.56)	0.01***(3.65)	0.011***(8.07)	0.003***(3.66)	0.005***(5.11)
GDP growth rate	0.007(0.75)	-0.003(-0.49)	0.007***(2.63)	0.004**(2.48)	0.003(0.98)
JSCBs	-0.4***(-3.52)	-0.03***(-3.65)	-0.19***(-5.25)	-0.05***(-6.18)	0.03(0.02)
CCBs	-0.34***(-3.24)	-0.05***(-3.88)	-0.23***(-4.88)	-0.07***(-5.88)	0.22***(6.88)
Observations	427	413	415	415	415
Hansen test	0.403	0.400	0.488	0.952	0.802
AR(1)	0.243	0.200	0.022	0.062	0.000
AR(2)	0.104	0.266	0.121	0.674	0.900

Notes: We use a two-step system GMM estimator.

The symbols *, **, ***, represent significance levels of 10%, 5%. and 1%, respectively. The variables insolvency risk (total), technical efficiency (total), pure technical efficiency (total), and efficiency-adjusted Lerner index (total) are the estimated coefficients for the test that the sum of the lagged terms is equal to zero. A significance level lower than 10% enables us to reject the null hypothesis that x does not have an impact on y. A significant and positive sign indicates that the impact is positive, while a significant and negative sign indicates a negative impact. The null hypothesis of the Hansen test is that instruments used are not correlated with residuals and so the overidentifying restrictions are valid. In AR (Arellano-Bond) tests for serial correlation in the first-differenced residuals, the null hypothesis is that errors in the first difference regression do not exhibit first/second order serial correlation.