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Does competition only impact on insolvency risk? New evidence from the Chinese banking industry

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Abstract

Purpose- This paper investigates the impact of competition on credit risk, liquidity risk, capital risk and insolvency risk in the Chinese banking industry during the period 2003-2013.

Design/methodology/approach- This study uses a Generalized Method of Moments (GMM) system estimator to examine the impact of competition on risk. In particular, translog specifications are used to measure the competition and insolvency risk.

Findings- The results show that greater competition within each bank ownership type (state-owned commercial banks, joint-stock commercial banks and city commercial banks) leads to higher credit risk, higher liquidity risk, higher capital risk, but lower insolvency risk.

Originality- This paper is the first piece of research testing the impact of competition on different types of risk in banking industry and it further contributes to the empirical literature by using a more accurate competition indicator (efficiency-adjusted Lerner index) and a more precise insolvency risk indicator (stability inefficiency).

JEL classification: G21, C14, D4

Keywords: Competition, risk, Chinese banking

1. Introduction

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 banking reforms has been to increase competitive conditions, enhance stability and improve the performance of the Chinese banking sector. State-owned commercial banks (SOCBs) dominate the industry. However, according to statistics from the China Banking Regulatory Commission (CBRC), the share of SOCB assets in total banking sector assets decreased between 2003 and 2013 to a low point of 43.3%. On the other hand, the joint-stock commercial banks (JSCBs) and city commercial banks (CCBs) have kept increasing in size and in 2013 they held 17.8% and 10.03% of total banking sector assets. Table 1 summarizes the assets of SOCBs, JSCBs, CCBs and total banking institutions in China over the period 2003-2013.

<<Table 1---about here>>

The Chinese banking industry has reduced its credit risk undertaken over the period 2003-2013. Non-performing loan ratios over the period 2011-2013 were kept at 1% which was lower than the figures for 2008-2010. The Chinese banking industry also reduced the capital risk. CBRC statistics show that, by the end of 2013, the average capital adequacy ratio of Chinese banks was 12.2% which increased by 1.6% compared to the previous year. In addition, the liquidity ratio of Chinese commercial banks was 44% by the end of 2013. The ratio was lower than the figure for 2012, which was 45.8%, but it was higher than the ones for 2010 and 2011 which were 42.2% and 43.2%, respectively.

There are two different views with regard to the relationship between competition and risk. These are: competition-fragility and competition-stability. The former argues that banks have the ability to withstand shocks and decrease risk-taking behaviour due to the fact that higher profitability can be earned through monopoly rents in a less competitive market (Allen and Gale, 2004; Boyd and De Nicole, 2005).

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. By allowing for imperfect correlation across individual firms' default probabilities, Martinez-Miera and Repullo (2010) suggest that there is a U-shape relationship between competition and risk; therefore, as the number of banks increases, the probability of bank default first declines but then increases. Overall, the issue of whether or not competition precedes bank stability or fragility is unresolved.

There are a few pieces of research investigating competitive conditions in the Chinese banking sector (see section 3). Our study contributes to the empirical literature on Chinese banking competition by testing the impact of competition on the risk-taking behaviour of Chinese banks. Furthermore, we fill

gaps in the banking literature by examining the effect of competition on bank stability in the following two ways: 1) rather than focusing only on insolvency risk (Liu et al., 2013; Liu and Wilson; 2013), our study investigates credit risk, liquidity risk, and capital risk; 2) we use an efficiency-adjusted Lerner index because it provides more robust results (Tabak et al., 2012) compared to the Lerner index used by most of the empirical studies; 3) rather than using Z-score as the indicator of insolvency risk (Liu et al., 2012, Liu et al., 2013; Liu and Wilson, 2013), the current study uses stability inefficiency as the indicator which provides more robust results. The investigation of this topic is particularly important in the Chinese banking industry due to the fact that as a result of this analysis, the Chinese government and banking regulatory authority can make more comprehensive policies not only on the whole banking industry, but also more importantly, relevant policies can be made specifically on different ownership types of Chinese commercial banks. This study not marginally but significantly contributes to the empirical research of the relationship between competition and risk by firstly testing the impact of competition on different types of risk-taking behavior.

The empirical results show that CCBs have the highest credit risk, followed by SOCBs, while JSCBs have the lowest credit risk. In addition, SOCBs are found to have the highest liquidity risk. Finally, the results indicate that the insolvency risk of SOCBs is the highest compared to the other bank ownership types. Our findings suggest that greater competition within each bank ownership type leads to higher credit risk, higher liquidity risk, higher capital risk but lower insolvency risk.

The rest of the paper is organized as follows: section 2 reviews the structure and reforms of the Chinese banking industry; section 3 reviews the literature regarding the impact of competition on risk-taking behaviour in the banking sector, as well as studies examining the competitive conditions in the Chinese banking industry; section 4 presents the methodologies and data used in the study; section 5 discusses the empirical results, which is followed by section 6 discussing the robustness check, while section 7 concludes the paper.

2. The Chinese banking industry

The Chinese banking system followed a mono-bank model before 1978. The Peoples' Bank of China (PBC) took the function of a central bank, as well as engaging in commercial bank operations. A series of economic reforms was initiated by the Chinese government in 1979 to transform the planned economy to a market-based economy. The banking sector in China was also rebuilt and redesigned. A two-tier banking system was created during the period 1979-1993, with the PBC free to serve as the

Central Bank and four SOCBs[1] to engage in commercial bank lending. A number of JSCBs[2] and rural and urban credit cooperatives were also established during this period. The SOCBs made loans to state-owned enterprises under government direction with no consideration of credit checks and risk monitoring which lead to the accumulation of non-performing loans. During this period, competition among Chinese banks was limited.

In order to alleviate the problem of large volumes of non-performing loans in SOCBs, three policy banks were established by the Chinese government in 1994. Their main functions were: 1) to take over the responsibilities undertaken by SOCBs previously and 2) to make loans in line with government policies. Thus, SOCBs were transformed gradually into true commercial banks and they had increasing freedom in terms of credit and lending decisions.

In order to reduce the volumes of non-performing loans in SOCBs, four asset management companies (AMCs) (Cinda AMC, Huarong AMC, Great Wall AMC and Oriental AMC) were established by the government in 1999, with each oriented to a specific state-owned bank. The AMCs purchased and managed non-performing loans and they were under the supervision of the PBC. There have been three non-performing loan write-offs by AMCs - in 1999, 2004 and 2005. In 1999, the four AMCs purchased RMB 1.4 trillion non-performing loans from the four SOCBs and China Development Bank. In 2004, non-performing loans worth RMB 278.7 billion were purchased by Cinda AMC from the Bank of China and the China Construction Bank. In 2005, non-performing loans worth RMB 142.4 billion were purchased by Oriental and Cinda AMC from the Bank of China, RMB 56.9 billion from the China Construction Bank and RMB 64 billion from the Bank of Communication. These purchases reduced the volumes of non-performing loans of Chinese SOCBs and increased their competitiveness in the world.

The Chinese government and banking regulatory authorities deal not only with the issue of non-performing loans, but take measures to increase competition in the banking sector, such as easing the licensing and entry requirements for new small and medium-sized domestic banks. A number of new JSCBs were established in 1996, 2004 and 2005[3]. Furthermore, in order for the banks to obtain external funds and in an attempt to increase competition among them, all the Chinese banks were encouraged to list on the stock exchange. By the end of 2013, all the SOCBs had offered successfully their initial public offerings (IPOs), with ICBC having raised US$21.9 billion on the Shanghai and

[1]They were the Bank of China (BOC), Agricultural Bank of China (ABC), China Construction Bank (CCB) and Industrial and Commercial Bank of China (ICBC).
[2] These banks include Citic Bank, China Merchant Bank, Shenzhen Development Bank, China Everbright Bank, Industrial Bank, Guangdong Development Bank, HuaXia Bank Shanghai Pudong Development Bank and Evergrowing Bank.
[3]They are: China Minsheng Bank, China Zheshang Bank and China Bohai Bank.

Hong Kong stock exchanges in 2006, becoming the largest IPO at that time. The successful listing of the Agricultural Bank of China on the Shanghai and Hong Kong Stock Exchanges in 2010 broke the record made by ICBC, and raised funds worth USD 22.1 billion, becoming the second largest IPO in the world until now, while eight of the 12 JSCBs have been listed on a variety of stock exchanges[4].

The CBRC, which is the primary government agency and point of control for commercial banks, was established by the State Council[5] in 2003. The CBRC is responsible not only for supervising commercial banking operations, but also for 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 their operations. The objective is to protect the interests of depositors and maintain market confidence through prudent and effective supervision.

At the end of 2013, the Chinese banking sector consisted of three policy banks, five large-scale (state-owned) commercial banks[6], 12 JSCBs, 145 CCBs and a large number of other financial institutions, such as credit cooperatives, foreign banks, trust companies and the finance companies of enterprise groups.

3. Literature review

There are few papers investigating the impact of competition on risk-taking behaviour in the banking sector. Using the Lerner index as the competition indicator, the ratio of non-performing loans over total loans and a Z-score as the indicators of credit risk and probability of default, Agoraki et al. (2011) investigate the impact of competition on risk in the central and eastern European banking sector over the period 1985-2005. The empirical findings suggest that banks with market power (due to lower competition) tend to take on lower credit risk and have a lower probability of default. 14 Asia Pacific economies are studied by Fu et al. (2014) from 2003 to 2010. The probability of bankruptcy and a bank's Z-score are used as risk indicators. The empirical results suggest that greater concentration fosters financial fragility, lowers pricing power and induces risk-taking. The impact of competition on risk-taking behaviour for a large sample of banks from different countries around the world during the period 1994 to 2009 is investigated by Beck et al. (2013). The empirical findings suggest that there is a significant impact of competition on banks' fragility in countries with stricter activity restrictions, lower systemic fragility, better developed stock exchanges, more generous deposit insurance and a more effective system of credit information sharing. Using a sample of European banks over the

[4] They are: China Merchant Bank, China Citic Bank, Hua Xia Bank, China Everbright Bank, Shanghai Pudong Development Bank, China Minsheng Bank, Industrial Bank and Ping An bank (Shenzhen Development bank).
[5] The State Council is the chief administrative authority of the People's Republic of China.
[6] They are: Bank of China (BOC), China Construction Bank (CCB), Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC) and Bank of Communication (BOCOM).

period 1995 to 2005, Schaeck and Cihak (2014) investigate the effect of bank competition on bank stability; the Z-score is used as the stability indicator, while the boone indicator is used to measure bank competition. The findings suggest that competition enhances bank stability but that the impact is stronger for healthy banks rather than ones with greater fragility. Using a large sample of banks across 63 countries over the period 1997-2009, Anginer et al. (2014) investigate the impact of competition on the systemic risk undertaken by banks. Their findings show that more diversified risks are undertaken by banks in an environment of greater competition.

Liu et al. (2013) investigate the effect of competition on bank stability using a sample of banks across 11 European countries over the period 2000-2008. The empirical findings suggest that there is an inverted U-shape relationship between regional bank competition and stability. Liu et al. (2012) use a sample of commercial banks across four Asia countries (Indonesia, Malaysia, Philippines and Vietnam) over the period 1998-2008 to investigate the impact of competition on the banks' risk-taking behaviour. Four risk indicators are used - loan loss reserve, loan loss provision, volatility of ROA and Z-score - while the Panzar-Rosse H statistic is used to measure bank competition. Their findings show that competition does not increase bank risk-taking behaviour.

Liu and Wilson (2013) investigate the impact of competition on risk-taking behaviour for different types of Japanese banks over the period 2002-2009. The Lerner index and a Z-score are used as competition and risk indicators, respectively. The empirical findings suggest that the effect of competition on bank risk varies across different types of Japanese banks, based on different initial levels of risk. To be more specific, their results show that the risk of City banks with higher initial levels of risk is reduced by increasing competition, while increasing competition leads to an increase in other bank ownership types with lower initial levels of risk.

Using a broad set of commercial banks over the period 1994-2009, Soedarmono et al. (2013) investigate the impact of bank competition on financial stability in emerging markets. The Lerner index is used to measure bank competition and various risk indicators are controlled (mainly focusing on capital risk and insolvency risk) which include total risk-based capital ratio; ratio of total equity to total assets; standard deviation of ROA; standard deviation of ROE; Z-score based on ROA as well as Z-score based on ROE. The empirical results indicate that a higher degree of market power (lower competition) leads to higher insolvency risk for banks and banks hold lower levels of capital in a more competitive banking environment.

There is a small number of studies examining competitive conditions in the Chinese banking industry. Yuan (2006) analyses the competitive conditions in the Chinese banking industry over the period 1996-2000. The results suggest that China's banking sector is already near to a state of perfect competition (that is before foreign banks began to enter China's financial markets). The competitive

conditions facing 16 Chinese banks during the period 2004-2007 are evaluated by Masood and Sergi (2011). The results show that the Chinese banking sector is monopolistically competitive over the period examined. Fu (2009) examines the competitive conditions for a panel of 76 Chinese banks over the period 1997-2007. The results indicate also that there is monopolistic competition in the Chinese banking sector. She suggests that, after China's accession to the WTO, competition in the core market for bank lending increases, while the off-balance-sheet market seems to become less competitive. Market concentration and competition in the Chinese banking industry over the period 1992-2008 is examined by Park (2013). The study indicates that the Chinese banking industry is still highly concentrated and that its level of competition is closer to oligopoly. Using the Lerner index as the competition indicator, Tan and Floros (2013) investigate the competitive conditions of Chinese SOCBs, JSCBs and CCBs over the period 2003-2011. The empirical findings suggest that competition among CCBs is the lowest over the examined period, followed by SOCBs, while competition among JSCBs is the highest. Tan (2014) uses both the Panzar-Rosse H statistic and the Lerner index to investigate the competitive conditions in the Chinese banking sector over the period 2003-2011. The empirical results suggest that the industry operates under monopolistic competition, while competition among CCBs is the lowest and competition among JSCBs is the highest. He further examines the impact of competition on risk-taking behaviour (credit risk and insolvency risk). The findings show that in a more competitive environment, Chinese commercial banks tend to undertake higher credit risk.

A number of studies have investigated the issue of competition on risk-taking behavior and more specifically, there are few studies investigating this issue in the Chinese banking industry. Most of the studies use the Lerner index as the competition indicator although there are few cases in which either the Boone indicator or Panzar-Rosse H statistics are used. The current study contributes to the empirical research by testing the competitive conditions in the Chinese banking industry using an efficiency-adjusted Lerner index. In addition, most of the empirical studies to date have focused on credit risk measured by non-performing loans, as well as insolvency risk measured by Z-score or volatility of bank return, although there was one case considering capital risk as well. The current study contributes significantly to the empirical studies by comprehensively examining different types of risk-taking behavior, in particular, the current study uses stability inefficiency as the indicator of insolvency risk. This fills a gap in the empirical literature with regard to the impact of competition on risk in banking.

4. Methodology

4.1. Efficiency-adjusted Lerner index

Previous studies have used different methods to investigate the competitive conditions in the banking industry (Al-Muharrami et al., 2006; Matthews et al., 2007; Jeon et al., 2011; Olivero et al., 2011; Tabak et al., 2012; Cipollini and Fiordelisi, 2012; Fungacova et al., 2014; Fu et al., 2014). The measurement of competition in the above mentioned studies mainly includes Panzar-Rosse H statistics, the Boone indicator and the Lerner index.

Although there are a number of studies which have used the Panzar-Rosse H statistic to investigate competition in the banking sector, it suffers from two main drawbacks. First, the H statistic was developed on the basis of a static model and there are no predictions of the H-statistic (Leuvensteijn et al., 2011). In other words, the estimate is surrounded by a degree of uncertainty. Secondly, the overall market equilibrium required by the test cannot be fulfilled because of market entry and exit, which leads to further limits on the interpretation of such an analysis (Claessens and Laeven, 2004).

The Boone indicator also suffers from two disadvantages. First, it makes the assumption that part of the efficiency gains achieved by banks are passed on to consumers. In addition, this indicator also suffers from idiosyncratic variation, i.e. uncertainty (see Tabak et al., 2012).

The Lerner index is defined as the difference between a bank's price and its marginal cost, divided by the price. The index value ranges from a maximum of 1 to a minimum of zero, with higher numbers indicating greater market power and hence lower competition. The Lerner index represents the extent to which a particular bank has market power to set its price above the marginal cost.

There are also arguments pointing up the disadvantage of the Lerner index. Fernandez de Guevara et al. (2005) argue that there are several problems when estimating the Lerner index. First, the value of the Lerner index changes according to different revenues used in their study. It is frequently the case that only interest and costs are considered while other non-interest revenues and expenses are omitted. Considering traditional loan-deposit services as revenue ignores the banking activities of providing other services that have grown substantially during recent years. This will lead to an inaccurate result when it comes to calculating competitive conditions in the banking sector. Secondly, the cost of risk, which is very important in the profit and loss account of banks, is generally not considered at all. Ignoring the cost of risk can be attributed to issues like insufficient data and calculation difficulties. If the cost of risk is not included when estimating the cost function, the Lerner index will be interpreted inaccurately because margins are overestimated. Thirdly, Bikker et al. (2007) argue that another weakness of the Lerner index is that the prices and costs required to calculate the index are not clearly identified by available bank balance sheet data, which leads to prices and costs being proxied for by many debatable factors.

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

$$efficiencyadjustedLernerindex_{it} = \frac{\pi_{it} + tc_{it} - mc_{it} * q_{it}}{\pi_{it} + tc_{it}} \quad (1)$$

Where i and t represent specific bank operating at a specific year, π represents bank profit which is measured by net income, tc represents total cost which is calculated by the sum of interest expenses as well as non-interest interests, q stands for earning assets. We use total loans and total securities as the measurement of earning assets. mc stands from marginal cost. The calculation can be explained as follows:

The marginal cost is estimated on the basis of a translog cost function with four outputs (total loans, total deposits, total securities and non-interest income) and two input prices (price of funds, price of capital). The specification of the translog cost function is shown as below (Tabak et al., 2012):

$$\ln(\frac{C}{W_2})_{it} = \delta_0 + \sum_j \delta_j \ln Y_{jit} + \frac{1}{2}\sum_j\sum_k \delta_{jk} \ln Y_{jit} \ln Y_{kit} + \beta_1 \ln(\frac{W_1}{W_2})_{it} + \frac{1}{2}\beta_{11} \ln(\frac{W_1}{W_2})_{it} \ln(\frac{W_1}{W_2})_{it} + \sum_j \theta_j \ln Y_{jit} \ln(\frac{W_1}{W_2})_{it} + \chi Dummy_{2004} + \phi Dummy_{2005} + \varphi T_t + \delta_2 DJ + \delta_3 DC + \varepsilon_{it} \quad (2)$$

where C represents total cost of the bank, Y represents four outputs including Y1 (total deposits), Y2 (total loans), Y3 (non-interest income) and Y4 (total securities), W stands for two input prices with W1 representing the price of funds which is measured by the ratio of interest expenses to total funding, W2 represents the price of capital, which is measured by the ratio of non-interest expenses to fixed assets, two input prices are considered due to the fact that non-interest expenses include the labour cost as well (Hasan and Morton, 2003). In other words, the price of capital considers the factors relating to the price of physical capital as well as the price of human capital. We also consider the technical innovations that happened in the banking sector over the examined period by including the time trend variable T_t. Two year dummy variables representing year 2004 and 2005 are included as well in the cost function due to the fact that Chinese government took a number of measures to deal with the non-performing loan issues of Chinese commercial banks, such as non-performing loans write-up and capital injection, it is supposed that it has a significant impact on the cost function. Due to the fact that we distinguish three different ownership types of Chinese commercial banks (state-owned commercial banks, joint-stock commercial banks and city commercial banks) and, we add two dummies DJ and DC for JSCBs, joint-stock commercial banks, and CCBs, city commercial banks.

The linear homogeneity is ensured by normalizing the dependent variable and W1 by anther input price W2. Table 2 provides the definition of the variables used to measure the efficiency-adjusted Lerner index while the summary statistics of the variables are reported in Table 3.

<<Table 2---about here>>

<<Table 3---about here>>

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:

$$MC_{ilt} = (\frac{C/W_2}{Y_l})_{it}(\delta_{j=l} + 2\delta_{ll}\ln Y_{ilt} + \sum_{k-1....k,k\neq l}\delta_{lk}\ln Y_{ikt} + \theta_l \ln(\frac{W_1}{W_2})_{it}) \quad (3)$$

4.2. Estimation of insolvency risk in the Chinese banking sector - stability inefficiency

The Z-score[7] has been used widely to measure the stability of financial institutions in empirical research (Iannotta *et al*. 2007; William and Prather, 2010; Liu and Wilson 2013; Liu et al. 2013; among others). Tabak et al. (2012) argue that the potential stability of banks is not necessarily reflected by the Z-score. The deviation from the bank's current stability and its maximum stability must be considered. We provide a measure of the bank's stability inefficiency by estimating a stochastic frontier (Aigner et al., 1977; Meeusen and Van den Broeck, 1977) with the Z-score as the dependent variable of the translog specification. The degree of stability inefficiency is measured how far a bank is off the maximum Z-score, i.e. the stochastic frontier. The equation we use to estimate the frontier can be expressed as follows. The explanatory part of the right hand side of below equation describes the maximal Z-score (so the least inefficiency/probability of default). A bank is highly inefficient/highly likely to default, if it has a very low Z-score, or ("maximal Z-score" – "Z-score of bank i") is large. A bank type is on average highly inefficient, if the mean of υ, μ, for that bank type is large.

[7] The Z-score reflects the extent to which banks have the ability to absorb losses. Thus, a higher value of the Z-score indicates lower risk and greater stability. The calculation of the Z-score can be expressed as follows:

$Z = \frac{ROA + E/A}{\sigma(ROA)}$ where ROA is banks' Return on Assets, E/A is the ratio of equity over total assets, $\sigma(ROA)$ is the standard deviation of Return on Assets.

$$\ln\left(\frac{Z-score}{W_2}\right)_{it} = \alpha_0 + \sum_j \delta_j \ln Y_{jit} + \frac{1}{2}\sum_j\sum_k \delta_{jk} \ln Y_{jit} Ln Y_{kit} + \beta_1 \ln\left(\frac{W_1}{W_2}\right)_{it} + \frac{1}{2}\beta_2 \ln\left(\frac{W_1}{W_2}\right)^2_{it}$$
$$+ \sum_j \theta_j \ln Y_{jit} Ln\left(\frac{W_1}{W_2}\right)_{it} + \gamma \ln(NPI) + \gamma_2 T_t + \vartheta Dummy_{2004} + \sigma Dummy_{2005} + \sigma_2 DJ + \sigma_3 DC + \nu_{it} - \upsilon_{it} \quad (4)$$

W represents input price: we consider two input prices which are the price of funds (the ratio of interest expenses over total funding) and the price of capital (the ratio of non-interest expenses over fixed assets). We follow Tabak et al. (2012) by employing a negative performance indicator (NPI) to address the issue of negative values of Z-score. This indicator will take the value of 1 when Z-score is equal or more than 0, while this indicator will be 0 if Z-score is less than 0. The dependent variable will take the value of 1 when it is negative. We did not include the macroeconomic variables in the above specification due to the fact that the estimation focuses on a single country rather than cross-countries. In order to be consistent compared to equation 2, we include time trend variable, two year dummy variables, as well as two ownership dummy variables representing two different bank ownership types, namely joint-stock commercial banks (DJ) and city commercial banks (DC) in the specification. The sub-indices i and t represent bank i operating at time t, while j and k represent different outputs. The error term ε_{it} equals $\nu_{it} - \upsilon_{it}$. The first term ν_{it} captures the random disturbance which is assumed to be normally distributed and represents measurement errors and other uncontrolled factors, i.e. ν_{it} ~N(0, σ_ν^2). The second term υ_{it} captures technical and allocative inefficiency, both under managerial control, and we assume it to be half-normally distributed, i. e. $\upsilon_{it} \sim N^+(\mu_{it,}\ \sigma_\upsilon^2)$. The inefficiency is calculated using a stochastic frontier model for panel data provided by the statistical software Stata through assuming that the inefficiency term is half-normally distributed[8].

4.3. Investigation of the impact of competition on the risk-taking behaviour of Chinese banks

In order to test the impact of competition on the risk-taking behaviour of the Chinese banking sector, the following equation is used:

$$\alpha_{it} = \beta_0 + \lambda\alpha_{i,t-1} + \beta_1 competition_{it} + \beta_2 competition^2_{it} + \beta_3 bankspecific_{it} + \beta_4 Macro_t + \beta_5 DJ + \beta_6 DC + \mu_i + \nu_{it} \quad (5)$$

In equation (5), α_{it} is the risk measure for bank i (i=1 ...N) at time t (t=1 ...T). Risk is measured by different variables including credit risk, liquidity risk, capital risk, and insolvency risk. Credit risk is measured by the ratio of impaired loans over gross loans, liquidity risk is measured by the ratio of total assets over liquid assets, capital risk is measured by the ratio of 1 over total regulatory capital ratio, while insolvency risk is measured by the stability inefficiency (Tabak et al., 2012) as discussed

[8] The estimation results of equation 4 can be requested from the corresponding author upon request.

earlier. A higher ratio of impaired loans over gross loans indicates that a bank has a higher credit risk; a higher figure of total assets over liquid assets shows that a bank has higher liquidity risk. In the case of the measurement of capital risk, a higher figure indicates higher capital risk. As discussed in the previous section, higher stability inefficiency underlines that there is a higher insolvency risk. $\alpha_{i,t-1}$ is a one period lagged risk measure. *Competition* is the measurement of bank competition in the Chinese banking sector. In the current study, it is measured by the efficiency-adjusted Lerner index. The quadratic term of the efficiency-adjusted Lerner index is also included to address the non-linear relationship between competition and risk, as suggested by Martinez-Miera and Repullo (2010). *Banksspecific* includes a number of bank-specific variables which have been found to have influence on bank risk, including bank size, diversification and overhead expenses. Bank size is measured by the natural logarithm of total assets, bank diversification is measured by the ratio of non-interest income over gross revenue, and overhead expenses are measured by the ratio of total overhead expenses to total assets. There is one macroeconomic variable included in the regression which is the annual inflation rate[9]. Finally, we distinguish between the three bank types. The intercept captures the effect of SOCBs while the coefficients in front of DJ and DC measure the difference of the effects of JSCBs and CCBs to SOCBs. In order to avoid possible endogeneity issues, the lagged values are used for all the independent variables in equation 5 to avoid possible endogeneity issues (except the dummy variables).

Following Agoraki et al. (2011), we expect that competition has a significant and positive impact on the credit risk and insolvency risk of Chinese commercial banks. We have no a priori expectation with regard to the impact of competition on liquidity risk due to the fact that, higher competition may reduce the volume of traditional loan business as well as non-traditional activities, the increase in the availability of funds in the banks further leads to an improvement in bank liquidity and a reduction in liquidity risk. However, higher competition may induce bank managers to reduce risk checking and so, the lower credit requirement will increase the credit granted to different companies. In other words, a larger volume of loan business engaged in by the Chinese commercial banks may reduce the liquidity level and further proceed to an increase in liquidity risk. Finally, following Soedarmono et al. (2013), we expect that in the Chinese banking industry, the impact of competition on capital risk is significant and negative.

We do not have any a priori expectation with regard to the impact of bank size on bank risk. On the one hand, large banks have the ability to reduce costs via economies of scale and economies of scope, and the larger market power derived from cost reduction improves bank stability (Berger, 1995). On the other hand, managers in larger banks have the incentive to take on higher risk because they expect that higher risk normally comes with higher returns, while the government will bail out distressed banks because they are "too big to fail" (O'Hara and Shaw, 1990).

[9] We previously followed Liu and Wilson (2013) and included GDP growth as well as a macroeconomic variable; however, it has automatically dropped out of the multicollinearity test. The test is not reported in this paper; however, it is available from the corresponding author upon request.

We expect that there will be a significant and positive relationship between diversification and bank risk. There are a number of studies which find that an increase in the volume of non-traditional activities increases risk in the US and European banking sectors (Stiroh, 2004; Mercieca et al., 2007; Laeven and Levine, 2007; Lepetit et al., 2008; Demirguc-Kunt and Huizinga, 2010).

We expect that the impact of overhead expenses on bank risk will be significant and negative. Agoraki et al. (2011) argue that banks with larger amounts of overhead expenses tend to take on higher risk with the purpose of generating higher returns.

We expect that the impact of inflation on bank risk is significant and negative. Lown and Morgan (2006) and Buch et al. (2014) argue that the financial system and the real economy are adversely affected by inflation. They suggest further that during a period of high inflation, decision making will be distorted, information asymmetry will be exacerbated and price will be volatile. In order to test whether the impacts of competition on various types of risk-taking behaviour in the Chinese banking industry are different across different bank ownership types, the interaction terms of the competition measure (lagged one year efficiency-adjusted Lerner index)[10] with bank ownership dummies are created.

We use a two-step system GMM estimator to estimate equation 5 (Arellano and Bover, 1995; Blundell and Bond, 1998). Second and higher-order lags and differences in the dependent variables are used as an instrument to address the issue of endogeneity arising from the inclusion of the lagged dependent variable. The Hansen test of over-identifying restriction is reported and we also provided the probability values for the first and second order autocorrelation in the error term (Hansen, 1982).

We use data for 100 Chinese commercial banks (5 SOCBs, 12 JSCBs and 83 CCBs) over the period 2003-2013. Due to the fact that the banks in the sample, especially the CCBs, do not have available data for all the years, we opt for an unbalanced panel dataset in order not to lose degrees of freedom. The data on competition, risk and bank-specific variables are collected from the bankscope database, while the macroeconomic variable is collected from the World Bank database. Table 4 gives a summary of the variables used in the current study, their measurements and data sources.

<<Table 4---about here>>

Figure 1 shows the competitive conditions of the Chinese banking industry over the period examined. They are presented for all three different ownership types. It is observed that the minimum value of the efficiency-adjusted Lerner index is 0.3, while the highest value is nearly 0.62. A comparison of these values with the values of the Lerner index from other countries shows that Chinese commercial

[10] The quadratic term of the efficiency-adjusted Lerner index is excluded due to the fact that the linear relationship between competition and risk-taking behaviour is found in equation 5.

banks have substantially higher market power. To be more specific, a piece of research undertaken by Carbo et al. (2009) shows that the values of the Lerner index for the European Union banking sector range from 11%-22%, while for developed countries, the average value of the Lerner index for the banking sectors is 22% (Berger et al., 2009). Fungacova et al. (2010) show that the value of the Lerner index for the Russian banking sector is 21.4%. These comparisons show that competition in the Chinese banking industry is very low. The lower level of competition in the Chinese banking industry can be explained partly by the fact that we use a more advanced efficiency-adjusted Lerner index while the others mentioned use a traditional Lerner index.

The efficiency-adjusted Lerner index suggests that between 2003 and 2013, city commercial banks have the highest market power compared to joint-stock commercial banks and state-owned commercial banks. In other words, the level of competition among city commercial banks is the lowest. The lower level of competition within CCBs can be explained as follows: 1) most of the SOCBs and JSCBs have listed already on the stock exchange, but most of the CCBs have not made their initial public offering yet, which lowers pressure to obtain funds from the general public and further reduces competition among them; 2) one of the characteristics of this banking ownership type is that most of the CCBs still operate within the city where they were established (although the geographical limitation for operation has already been removed for CCBs which had better performance). In other words, each CCB just serves the enterprises within their own city; this leads to a decline in bank competition. Finally, the figure shows state-owned commercial banks have higher market power than joint-stock commercial banks over the examined period.

<<Figure 1---about here>>

Figures 2a, 2b, 2c, and 2d report the risk conditions of Chinese banks over the period 2003-2013, as measured by the the ratio of impaired loans to gross loans (credit risk); the ratio of total assets over liquid assets (liquidity risk); the ratio of 1 over total capital regulatory adequacy ratio (capital risk); and stability inefficiency (insolvency risk). Figure 2a shows that over the period 2003-2008, the credit risk of SOCBs is substantially higher than that of JSCBs and CCBs, while the large volume of non-performing loans in SOCBs is attributed mainly to the fact that one of the banks - the Agricultural Bank of China - had non-performing loan ratios of over 23% during the period 2003-2007. Although the figure shows that after 2008, all the three different ownership types of Chinese commercial banks have few differences with regards to credit risk, the credit risk of CCBs is higher than that of JSCBs between 2005-2010. The low credit risk of JSCBs is attributed mainly to the fact that the participation of foreign investors in domestic JSCBs improves the techniques of risk management and further precedes a decline in credit risk. The significantly lower amount of credit risk for all three different ownership types of Chinese banks after 2008 is attributed to the financial crises which induced the

government and banking regulatory authorities to improve credit checking, risk monitoring and risk management.

<<Figure 2a---about here>>

liquidity risk, as represented in Figure 2b, shows that in general, the ratio of total assets over liquid assets for SOCBs is higher than that of JSCBs and CCBs. In other words, the SOCBs have the highest liquidity risk. This can be explained by the fact that SOCBs mainly make loans to large enterprises around the country; the loan demand for which is substantially higher than that for medium and small enterprises, which are served by JSCBs and CCBs. SOCBs also engage in a larger amount of business in derivatives and securities. The engagement of diversified activities further decreases liquidity. However, liquidity is the highest in CCBs over the period 2005-2008. This can be explained by the fact that they mainly have a simple business scope and have little engagement in non-traditional activities. Furthermore, the loans made by CCBs focus on small enterprises within cities, the amount of which is much smaller than for SOCBs. The JSCBs have the highest liquidity after 2010. We explain this improvement in liquidity by the fact that the annual meeting of directors of JSCBs was held in 2010 and subsequently the China Banking Regulatory Commission has emphasized the importance of further increases in the liquidity of JSCBs.

<<Figure 2b---about here>>

Compared to city commercial banks and state-owned commercial banks, joint-stock commercial banks have highest volatility in the levels of capital over the examined period. In general, the capital level of CCBs kept increasing for most of the years over the period examined, although CCBs showed a slight decrease in some of the years. This increase in capital levels is attributed to the contribution from city level government.

<<Figure 2c---about here>>

We look at the insolvency risk of the Chinese banking industry on a year by year basis, which is reflected by stability inefficiency (Figure 2d). The figure shows that the insolvency risk was more volatile during 2003-2006; while during 2007-2013, they reduced. The stronger volatility over the period 2003-2006 can be explained by the fact that there was a large amount of non-performing loans in Chinese commercial banks, especially SOCBs, and that the capital level of SOCBs was quite low. Furthermore, the Chinese government initiated a number of measures to deal with it, such as capital injection and non-performing loan write-off, while the financial crisis of 2007-2008 induced bank managers to be more careful in conducting business. The 2008 Olympic Games held in Beijing further promoted the economic growth of China. The resultant decline in the probability of default decreased the risk and increased the capital level of Chinese commercial banks.

<<Figure 2d---about here>>

5. Results and discussion

The summary statistics of the variables used in the study are provided in Table 5. They show that Chinese commercial banks have large differences with regard to credit risk and liquidity risk. The large difference in the credit risk undertaken by Chinese commercial banks indicates that Chinese commercial banks have different risk management capabilities and strategies, while the large difference in the credit risk undertaken is attributed to some extent to the large volume of non-performing loans which existed in SOCBs between 2003 and 2005. The large difference in the liquidity position held by Chinese commercial banks lies in the fact that compared to joint-stock commercial banks and city commercial banks, state-owned commercial banks mainly focused on making loans to large enterprises with big projects, the resulted substantially larger volumes of loan demand from the state-owned commercial banks lead to a bigger difference with regard to the liquidity condition among Chinese commercial banks.

Table 5 indicates further that Chinese commercial banks have greater market power, with an efficiency-adjusted Lerner index ranging from 0.3 to 0.62, while there is a bigger difference with regard to the size of Chinese commercial banks. SOCBs and JSCBs are larger than CCBs, as measured by total assets. There is quite a big difference with regards to the non-interest business engaged in by Chinese commercial banks. The statistics show that some Chinese commercial banks have negative non-interest income. This finding indicates that some Chinese commercial banks still lack experience and knowledge in relation to non-traditional activities, while in order to attract more customers, some Chinese commercial banks do not charge for services provided in relation to non-traditional business, while higher operational costs lead to a loss on these transactions. However, it is found that there is not too big a difference among Chinese commercial banks in relation to overhead expenses.

<<Table 5---about here>>

We test the stationarity of the residuals in the cost function using Levin-Lin and Chiu unit root test, the result of which is reported in Table 6. The results show that the residuals are stationary. Table 7 presents the empirical results for equation 5. The explanatory powers of the models are reasonably high, while the Wald test statistics for all models are significant at the 1% level. The Hansen test shows that there is no evidence of over-identifying restrictions. Even though the equation indicates that first-order autocorrelation is present, this does not imply that the estimates are inconsistent. All the second-order autocorrelations are rejected which guarantees the consistency of the estimation.

The results show that the one period lagged dependent variables are all significant which indicates that various types of risk-taking behaviour of Chinese commercial banks in the current year are affected significantly by the previous year. All the one period lagged dependent variables are significant and positive with regard to credit risk, liquidity risk, and capital risk, while the sign of the coefficient of stability inefficiency is significant and negative, suggesting that stability inefficiency is more volatile compared to the other types of risk-taking behaviour of Chinese commercial banks. The efficiency-adjusted Lerner index is significant for all kinds of risk-taking behaviour, which indicates that there is a linear relationship between competition and the risk-taking behaviour of Chinese commercial banks. However, the square term of the efficiency-adjusted Lerner index is significant for credit risk and insolvency risk, which suggests that there is a U-shaped relationship between competition and these two types of risk-taking behaviour in the Chinese banking industry. In order to confirm whether the impact of competition on the risk-taking behaviour of Chinese banks is linear or not, we calculate the inflection points[11]. The results show that the inflection point for credit risk is above the maximum value of the efficiency-adjusted Lerner index, while the inflection point of stability inefficiency is below the minimum value of the efficiency-adjusted Lerner index. These findings confirm that there is a linear relationship between competition and risk-taking behaviour in the Chinese banking industry. Our results are in different contrast with Tabak et al. (2012) with regard to a sample of Latin American countries and Liu et al. (2013) in terms of a sample of European countries. Both of these two pieces of research reported that competition has non-linear impact on the banks' risk-taking behaviour. The different finding between this study and the empirical research is mainly attributed to the following factors: 1) different banking sectors are examined with the current study examines the Chinese banking industry, while another two mentioned above examine the Latin American Industry as well as the European banking industry; 2) different indicators are used to measure the competition with the current study uses efficiency-adjusted Lerner index and another two mentioned above use the Boone indicator and the Lerner index.

The results suggest that Chinese commercial banks with more diversified activities have a higher volume of impaired loans, as reflected by the significant and positive sign of the coefficient. In other words, more diversified activities lead to higher credit risk. We explain this finding by the fact that banks engaging in a number of different interest and non-interest generating activities have less incentive to monitor the loan business, which leads to an increase in the volume of impaired loans and an increase in credit risk. Bank diversification is significantly and negatively related to the liquidity risk of Chinese commercial banks. This finding can be attributed to the fact that larger volumes of different activities engaged in by banks reduce their dependence on the loan business. The resulting

[11] The inflection point is calculated by setting the first-order derivative to zero and comparing its value to the empirical distribution of the efficiency-adjusted Lerner index.

decrease in the volume of loans and increase in the volume of fee business services provided by banks increase liquidity. Chinese banks with more diversified activities have higher capital risk. The finding can be explained by the fact that Chinese commercial banks still lack the experience of skills in engaging in certain types of non-interest generating business and that capital is used to absorb the losses on these transactions. Finally, it is found that Chinese banks with higher levels of diversification have lower insolvency risk. Overhead expenses are significantly and positively related to the credit risk of Chinese commercial banks. This finding can be explained by the fact that Chinese commercial banks with higher volumes of overhead expenses do not have very well developed management systems. It indicates further that the banks do not manage and monitor risk very well, while poor monitoring and management processes precede an increase in credit risk. The results indicate also that Chinese banks with higher overhead expenses have lower liquidity risk and lower capital risk. For the banks with larger volumes of non-performing loans, it is expected that bank profitability will be affected negatively, while poorer performance induces customers to switch their deposits to other banks. The purpose of higher liquidity is to deal with sudden withdrawals, while a higher level of capital is necessary to absorb negative shocks.

We find that bank size is significantly and negatively related to the credit risk of Chinese commercial banks, which indicates that large commercial banks have lower credit risk. This can be explained by the fact that large Chinese commercial banks have a greater expertise in risk monitoring and management. It is also found that Chinese commercial banks with larger size have higher liquidity. The results show that larger Chinese commercial banks have lower capital risk, which indicates that they have higher levels of capital. Finally, the findings show that large Chinese banks have lower insolvency risk (higher stability), as reflected by their stability inefficiency.

We find that higher inflation leads to lower credit risk for Chinese commercial banks. This finding can be explained by the fact that in order to deal with higher inflation, the interest rate will be raised, the borrowing cost for different firms will be increased and the banks will grant loans to companies with better performance, which leads to a decline in credit risk. The results show also that capital risk for Chinese banks is lower during periods of high inflation. The results suggest that compared to the SOCBs, CCBs have higher credit risk and JSCBs have lower credit risk. This finding can be attributed to the fact that CCBs mainly make loans to small enterprises within cities; the capital levels of which are much lower than those of large and medium size enterprises. The adverse economic environment will affect the probability of loan repayment which precedes an increase in credit risk, while the lower credit risk of JSCBs can be attributed to foreign participation in the operations of the banks.

JSCBs and CCBs have lower liquidity risk than SOCBs. This finding can be attributed to the fact the SOCBs mainly make loans to large sized enterprises in China. The demand for loans is much higher, and the higher volumes of loans provided by SOCBs reduce the liquidity levels of the banks.

The significant and negative signs of the coefficients of JSCBs and CCBs, when investigating stability inefficiency, indicate that compared to SOCBs, JSCBs and CCBs have lower insolvency risk. The higher stability inefficiency of SOCBs is attributed mainly to the fact that during 2003-2005 these banks had large volumes of non-performing loans as well as lower capital levels.

Finally, we test the autocorrelation in the residuals using the Cumby-Huizinga test. The results of which are reported in Table 8. The results show that the first-order autocorrelation is present for all different types of risk and there is no second-order correlation, which is line with the results of the GMM estimation as reported in Table 7.

<<Table 6---about here>>

<<Table 7---about here>>

<<Table 8---about here>>

Table 9 reports the empirical results regarding the impact of competition on risk-taking behaviour across different bank ownership types. The interaction terms of the efficiency-adjusted Lerner index and bank ownership are all significant and negative for credit risk, indicating that greater competition within each bank ownership type leads to higher credit risk. All the negative and significant coefficients of the interaction terms, with regards to liquidity risk, suggest that greater competition within different bank ownership types leads to higher liquidity risk. All the significant and positive coefficients of the interaction terms indicate that greater competition within each bank ownership leads to higher capital risk. Finally, the results show that greater competition within each bank ownership type precedes a decline in insolvency risk. The positive impact of competition on credit risk can be explained by the fact that stronger competition induces bank managers to reduce the requirement of credit conditions with regard to allocating loans to different businesses, which leads to a larger volume of non-performing loans and higher credit risk. In terms of the impact of competition on liquidity risk, our finding can be explained by the fact that higher competition induces bank managers to engage in a greater number and variety of businesses in order to generate a higher volume of earnings, especially engaging in a larger volume of long-term business which significantly reduces bank liquidity and further precedes an increase in liquidity risk. The positive impact of competition on capital risk can be explained by the fact that certain amounts of capital will be used to engage in different businesses which reduces the capital level and further increases the capital risk. Finally, the negative impact of competition on insolvency risk is attributed to the fact that stronger competition

induces bank managers to engage in a variety of business rather than focusing on the traditional loan-deposit services, the cost reduction derived from economies of scale together with the benefit from economies of scope increase the banks' ability to meet their financial obligations, thus leading to a reduction in insolvency risk.

As indicated by the size of the coefficients, the results show that greater competition leads to the greatest increase in the risk-taking behaviour of CCBs with regards to credit risk, liquidity risk and capital risk, while an increase in competition will reduce the insolvency risk of SOCBs to the greatest extent.

<<Table 9---about here>>

6. Robustness check

We also ran three alternative tests to see whether our results are robust. First, we use different risk indicators to cross-check the robustness of the results. The ratio of loan loss provisions to total loans is used to measure credit risk. Liquidity risk is measured by the ratio of loans to total assets. The ratio of shareholders' equity to total assets is used to measure capital risk. The Z-score is used as the indicator of insolvency risk. The results are quantitatively similar compared to the main results reported in this paper. Secondly, rather than use the GMM two-step system estimator, we double check the robustness of the results by employing a GMM two-step system estimator with Windmeijer's correction for standard errors, which is supposed to provide more robust results. Furthermore, rather than using the dynamic model estimated by the GMM estimator, we run alternative regressions including and excluding the lagged dependent variable estimated by the ordinary least square (OLS) estimator and the fixed effort (FE) estimator. The results suggest that the coefficient on the lag of the dependent variable for the dynamic model is between those of the FE and OLS model, which show that our estimates are correct. Finally, we exclude the financial crisis period and re-run the regression; the results are still hold[12].

7. Summary and conclusions

This paper investigates the impact of competition on the risk-taking behaviour of Chinese commercial banks over the period 2003-2013. Three different ownership types of Chinese commercial banks are considered: SOCBs, JSCBs and CCBs. Our findings suggest that CCBs have the highest credit risk compared to JSCBs and CCBs, while the liquidity risk of SOCBs is the highest. It is found that the insolvency risk of SOCBs is higher than that of JSCBs and CCBs. Greater competition within each bank ownership type leads to greater risk-taking behaviour by Chinese commercial banks (credit risk,

[12] The results with regard to the robustness check are not reported in the current paper, however, they are available from the corresponding author upon request.

liquidity risk, and capital risk). However, greater competition within each different type of bank ownership leads to lower insolvency risk.

The Chinese government and banking regulatory authorities have attached greater importance to the risk-taking behaviour of Chinese commercial banks since the financial crisis which occurred in Asia in 2007-2008. However, this study is the first to investigate comprehensively the risk conditions in the Chinese banking industry. It is also the first piece of research to investigate the impact of competition on the risk-taking behaviour of Chinese commercial banks over the period 2003-2013. In a more general way, this research extends the empirical studies of Liu and Wilson (2013) and Liu et al. (2013) in relation to the Japanese and European banking sectors in the following ways: 1) rather than focusing on insolvency risk, we examine comprehensively the risk conditions of Chinese commercial banks by including credit risk, liquidity risk and capital risk, as well as insolvency risk; 2) insolvency risk is measured by stability inefficiency rather than Z-score, which provides more robust results; 3) we check the robustness of the results by using different measurements of risk as well as different econometric techniques; 4) efficiency-adjusted Lerner index is used as the indicator of competition which provides more accurate results.

The results provide policy implications for the Chinese government and its banking regulatory authority as follows: 1) Chinese city commercial banks should enhance further the risk monitoring and management process in order to reduce credit risk; 2) the Chinese government should reduce the degree of support to Chinese state-owned commercial banks; the lower level of government support will reduce the insolvency risk; 3) although greater competition makes Chinese commercial banks more solvent, it is recommended that competition should be controlled to a certain degree to reduce the credit risk, liquidity risk, and capital risk of Chinese commercial banks.

The current paper suffers from a number of limitations. First, the measurement of risk variables can be improved. To be more specific, the accounting ratio is used to measure the liquidity risk in the current paper, while a future study can consider using the maturity of the assets and liabilities, and calculate the maturity gap. Secondly, the current study uses the efficiency-adjusted Lerner index to measure the competitive conditions. This can be improved in future studies by using the Boone indicator to measure the competitive conditions, which has the advantage of evaluating the competitive conditions in different banking markets such as loan markets, and deposit markets, as well as the non-interest income market.

References

Agoraki, M. K., Delis, M. D. and Pasiouras, F. (2011), "Regulations, competition and bank risk-taking in transition countries", *Journal of Financial Stability*, Vol. 7 No. 1, pp. 38-48.

Aigner, D., Lovell, C. A. and Schmidt, P. (1977), "Formulation and estimation of stochastic frontier production function models", *Journal of Econometrics*, Vol. 6 No. 1, pp. 21-37.

Anginer, D., Demirguc-Kunt, A. and Zhu, M. (2014), "How does Bank competition affect systemic stability?", *Journal of Financial Intermediation*, Vol. 23 No. 1, pp. 1-26.

Allen, F. and Gale, D. (2004), "Competition and financial stability", *Journal of Money, Credit and Banking*, Vol. 36 No. 3, pp. 433-480.

Al-Muharrami, S., Matthews, K. and Khabari, Y. (2006), "Market structure and competitive conditions in the Arab GCC banking system", *Journal of Banking and Finance*, Vol. 30 No. 12, pp. 3487-3501.

Arellano, M. and Bover, O. (1995), "Another look at the instrumental variable estimation of error-components models", *Journal of Econometrics*, Vol. 68 No. 1, pp. 29-51.

Beck, T., Jonghe, O. and Schepens, G. (2013), "Bank competition and stability: cross-country heterogeneity", *Journal of Financial Intermediation*, Vol. 22 No. 2, pp. 218-244.

Berger, A. N. (1995), "The profit-structure relationship in banking-tests of market-power and efficient-structure hypotheses", *Journal of Money, Credit and Banking*, Vol. 27 No. 2, pp. 404-415.

Berger, A. N., Klapper, L. and Turk-Ariss, R. (2009), "Bank competition and financial stability", *Journal of Financial Services Research*, Vol. 35 No. 2, pp. 849-870.

Bikker, J. A., Spierdijk, L., and Finnie, P. (2007). "The impact of market structure, contestability and institutional environment on bank competition", DNB working paper No. 156, De Nederlandsche Bank, Amsterdam.

Blundell, R. and Bond, S. (1998), "Initial conditions and moment restrictions in dynamic panel data models", Journal of Econometrics, Vol. 87 No. 1, pp. 115-143.

Boyd, J. and DeNicolo, G. (2005), "The theory of bank risk-talking revisited", *Journal of Finance*, Vol. 60 No. 3, pp. 1329-1343.

Buch, C.M., Eickmeier, S. and Prieto, E. (2014), "Macroeconomic factors and Microlevel Bank Behavior", *Journal of Money, Credit and Banking*, Vol. 46 No. 4, pp. 715-751.

Carbo, S., Humphrey, D., Maudos, J. and Molyneux, P. (2009), "Cross-country comparisons of competition and pricing power in European banking", *Journal of International Money and Finance*, Vol. 28 No. 1, pp.115-134.

Cipollini, A. and Fiordelisi, F. (2012), "Economic value, competition and financial distress in the European banking system", *Journal of Banking and Finance*, Vol. 36 No. 11, pp. 3101-3109.

Claessens, S. and Laeven, L. (2004), "What drives Bank Competition? Some International Evidence", *Journal of Money, Credit and Banking*, Vol. 36 No. 3, pp. 563-584.

Clerides, S., Delis, M.D. and Kokas, S. (2015), "A new Data Set on Competition in National Banking Markets", *Financial Markets, Institutions and Instrument,* Vol. 24 No. 2-3,: pp. 267-311.

Demirguc-Kunt, A. and Huizinga, H. (2010), "Bank activity and funding strategies: the impact on risk and returns", Journal of Financial Economics, Vol. 98 No. 3, pp. 626-650.

Fernandez de Guevara, J., Mandos, J. and Perez, F. (2005), "Market power in European banking", *Journal of Financial Services Research*, Vol. 27 No. 2, pp. 109-137.

Fu, M. (2009), "Competition in Chinese commercial banking", Banking and Finance Review, Vol. 1 No. 1, pp. 1-16.

Fu, X., Liu, Y. and Molyneux, P. (2014), "Bank competition and financial stability in Asia Pacific", *Journal of Banking and Finance*, Vol. 38, pp. 64-77.

Fungacova, Z., Solanko, L. and Weill, L. (2010), "Market power in the Russian banking industry", *International Economics*, Vol. 124, pp. 127-145.

Fungacova, Z., Pessarossi, P. and Will, L. (2013), "Is bank competition detrimental to efficiency? Evidence from China", *China Economic Review*, Vol. 27, pp. 121-134.

Fungacova, Z., Solanko, L. and Weill, L. (2014), "Does competition influence the bank lending channel in the Euro area", *Journal of Banking and Finance*, Vol. 49, pp. 356-366.

Hansen, L.P. (1982), "Large sample properties of generalized method of moments estimators", *Econometrica*, Vol. 50 No. 4, pp. 1029-1054.

Iannotta, G., Nocera, G. and Sironi, A. (2007), "Ownership structure, risk and performance in the European banking industry", *Journal of Banking and Finance*, Vol. 31 No. 7, pp. 2127-2149.

Jeon, B. N., Olivero, M P. and Wu, J. (2011), "Do foreign bank increase competition? Evidence from emerging Asian and Latin American banking markets", Journal of Banking and Finance, Vol. 35 No. 4, pp. 856-875.

Laeven, L. and Levine, R. (2007), Is there a diversification discount in financial conglomerates? *Journal of Financial Economics*, Vol. 85 No. 2, pp. 331-367.

Lepetit, L., Nys, E., Rous, P. and Tarazi, A. (2008). Bank income structure and risk: an empirical analysis of European banks. *Journal of Banking and Finance*, Vol. 32 No. 8, pp. 1452-1467.

Leuvensteijn, M. V., Bikker, J. C., Rixtel, A.A.R.J.M.V. and Sorensen, C. K. (2011), "A new approach to measuring competition in the loan markets of the euro area", *Applied Economics*, Vol. 43 No. 23, pp. 3155-3167.

Liu, H. and Wilson, J.O.S. (2013), "Competition and risk in Japanese banking", *European Journal of Finance*, Vol. 19 No 1, pp. 1-18.

Liu, H., Molyneux, P. and Wilson, J.O.S. (2013), "Competition and stability in European Banking: A regional Analysis", *Manchester School*, Vol. 81 No. 2, pp. 176-201.

Liu, H., Molyneux, P. and Nguyen, L.H. (2012), "Competition and risk in South East Asian commercial banking", Applied Economics, Vol. 44 No. 28, pp. 3627-3644.

Lown, C. and Morgan, D.P. (2006), "The credit cycle and the business cycle: new findings using the loan officer opinion survey", *Journal of Money, Credit and Banking*, Vol. 38 No. 6, pp. 1575-1597.

Martunez-Miera, D. and Repullo, R. (2010), "Does Competition Reduce the Risk of Bank Failure", *Review of Financial Studies*, Vol. 23 No. 10, pp. 3638-3664.

Masood, O. and Sergi, B.S. (2011), "China's banking system, market structure and competitive conditions", *Frontier of Economics in China*, Vol. 6 No. 1, pp. 22-35.

Matthews, K., Murinde, V. and Zhao, T. (2007), "Competitive conditions among the major British Banks", *Journal of Banking and Finance*, Vol. 31 No. 7, pp. 2025-2042.

Meeusen, W. and Van de Broeck, J. (1977), "Efficiency estimation from Cobb-Douglas production functions with composed error", *International Economic Review*, Vol. 18 No. 2, pp. 435-444.

Mercieca, S., Schaeck, K. and Wolfe, S. (2007), "Small European Banks: benefits from diversification", *Journal of Banking and Finance*, Vol. 31 No. 7, pp. 1975-1998.

O'Hara, M. and Shaw, W. (1990), "Deposit insurance and wealth effects: The benefit of being too big to fail", *Journal of Finance*, Vol. 45 No. 5, pp. 1587-1600.

Olivero, M. P., Li, Y. and Jeon, B. N. (2011), "Competition in banking and the lending channel: Evidence from bank-level data in Asia and Latin America", Journal of Banking and Finance, Vol. 35 No. 3, pp. 560-571.

Park, K.H. (2013), "Testing for competition in the South Korean and Chinese Commercial Banking Markets", Asia-Pacific Journal of Financial Studies, Vol. 42 No. 1, pp. 56-75.

Prather, L. and Williams, B. (2010), "Bank risk and return: the impact of bank non-interest income", *International Journal of Managerial Finance*, Vol. 6 No. 3, pp. 220-244.

Schaeck, K., Cihak, M. (2014), "Competition, efficiency and stability in Banking", Financial Management, Vol. 43 No. 1, pp. 215-241.

Soedarmono, W., Machrouh, F. and Tarazi, A. (2013), "Bank competition, crisis and risk taking: Evidence from emerging markets in Asia", *Journal of International Financial Markets, Institutions and Money*, Vol. 23, pp. 196-221.

Stiroh, K.J. (2004), "Diversification in banking: Is Noninterest Income the Answer", Journal of Money, Credit and Banking, Vol. 36 No. 5, pp. 853-882.

Tabak, B.M., Fazio, D.M. and Cajueiro, D.O. (2012), "The relationship between banking market competition and risk-taking: Do size and capitalization matter", *Journal of Banking and Finance*, Vol. 36 No. 12, pp. 3366-3381.

Tan, Y. and Floros, C. (2013), "Market power, stability and performance in the Chinese banking industry", *Economic Issues*, Vol. 18 No. 2, pp. 65-89

Tan, Y. (2014), *Performance, Risk and Competition in the Chinese Banking Industry*, Chandos Publishing, Oxford.

Yuan, Y. (2006), "The state of competition of the Chinese banking industry", *Journal of Asia Economics*, Vol. 17 No. 3, pp. 519-534.

Table 1 Summary of the assets of SOCBs, JSCBs, CCBs and total banking institutions in China over the period 2003-2013

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SOCBs	160512 (58.03%)	179817 (56.9%)	210050 (56.1%)	242364 (55.2%)	285000 (53.7%)	325751 (51.59%)	407998 (51.31%)	468943 (49.2%)	536336 (47.34%)	600401 (52.84%)	656005 (43.34%)
JSCBs	29599 (10.7%)	36476 (11.5%)	44655 (11.92%)	54446 (12.4%)	72742 (13.69%)	88337 (13.99%)	118181 (14.86%)	149037 (15.64%)	183794 (16.22%)	235271 (20.71%)	269361 (17.8%)
CCBs	14622 (5.3%)	17056 (5.4%)	20367 (5.44%)	25938 (5.9%)	33405 (6.29%)	41320 (6.54%)	56800 (7.14%)	78526 (8.24%)	99845 (8.81%)	123469 (10.87%)	151778 (10.03%)
Banking institutions	276584	315990	374697	439500	531160	631515	795146	953053	1132873	1136224	1513547

Table 2 The definition of variables used to estimate the efficiency-adjusted Lerner index

Abbreviation	Variable	Measurement
tc	Total cost	Interest expenses plus non-interest expenses
Y (outputs)	Total loans	
	Total deposits	
	Total securities	
	Non-interest income	
π	Bank profitability	Net income
q	Earning assets	Total loans and total securities
W	Input prices	Input price 1: price of funds- ratio of interest expenses over total funding Input price 2: price of capital- ratio of non-interest expenses over fixed assets
mc	Marginal cost	
T	Time trend variable	

Table 3 Summary statistics

Variables	Observations	Mean	S.D	Min	Max
Total cost (interest expenses and non-interest expenses)	777	3.35	0.97	-0.79	6.86
Price of funds (the ratio of interest expenses to total deposits)	777	1.27	0.18	0.74	1.96
Price of capital (the ratio of non-interest expenses to fixed assets)	776	1.92	0.26	0.68	2.83
Total loans	784	4.59	0.99	0.34	7.95
Securities	782	4.21	1.04	-0.41	7.87
Non-interest income	767	2.34	1.1	-2.4	5.81
Total deposits	784	4.85	0.98	0.66	8.26

Table 4 Variable definitions and sources

Variable	Definition	Data sources
Dependent variables		
Credit risk	Ratio of impaired loans over gross loans	Bankscope
Liquidity risk	Ratio of total assets over liquid assets	Bankscope
Capital risk	The ratio of 1 over Total regulatory capital ratio	Bankscope
Insolvency risk	Stability inefficiency	Bankscope
Independent variables		
Efficiency-adjusted Lerner index	See methodology	Bankscope
Bank size	Natural logarithm of total assets	Bankscope
Bank diversification	The ratio of non-interest income over gross revenue	Bankscope
Overhead	Ratio of overhead expenses over total assets	Bankscope
Inflation	Annual inflation rate	World bank (database)

Table 5 Summary statistics of the variables

	Observations	Mean	Standard deviation	Minimum	Maximum
Credit risk	632	2.78	4.48	0	41.86
Liquidity risk	777	4.38	1.18	2.5	7.9
Capital risk	637	0.091	0.05	0.061	0.141
Insolvency (stability inefficiency)	1100	0.32	0.18	0.19	0.8
Efficiency-adjusted Lerner index	800	0.53	0.18	0.3	0.62
Bank size	843	4.9	0.99	0.71	8.51
Bank diversification	828	13.98	13.31	-12.94	79.4
Overhead	788	0.01	0.004	0.002	0.04
Inflation	1227	2.86	1.92	-0.77	5.86

Table 6 unit root test for the residuals of the cost function

Levin-Lin-Chu unit-root test for the residuals of the cost function

	Statistics	**P-value**
Unadjusted t	-3.57	
Adjusted t	-2.67	0.004

Ho: Panels contain unit root and are not stationary

H1: Panels do not contain unit root and are stationary

Table 7 Risk-taking behaviour across different bank ownerships

Variable	Dependent variable: credit risk		Dependent variable: liquidity risk		Dependent variable: capital risk		Dependent variable: stability inefficiency	
	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat
Independent variables								
Lag of dependent variable	0.28***	5.56	0.26***	2.69	0.18***	11.45	-0.25***	-4.49
Bank competition (efficiency-adjusted Lerner index)	5.33*	1.63	-2.88**	-2.25	-10.16**	-2.08	312.48***	4.11
Bank competition 2	-4.48**	-2.05	1.32	0.88	-7.25	-0.98	-202.7***	-4.14
Bank diversification	0.03***	2.79	-0.02***	-3.88	0.008**	2.25	-0.002**	2.55
Overhead	16.18***	6.63	-12.35**	-2.29	-5.53***	-2.82	5.27	0.61
Bank size	-0.55***	-5.38	-0.85***	-4.33	-0.2***	-6.55	-0.19***	-2.83
Inflation	-0.03***	-5.99	-0.004	-0.95	-0.077***	-3.65	0.012	0.38
Joint-stock banks	-0.38***	-8.18	-0.59***	-4.38	0.004	0.38	-0.38***	-3.66
City banks	0.78***	-9.95	-1.28***	-4.95	0.41	0.55	-0.32***	3.38
Constant	-0.74	-0.52	4.27	1.12	-5.62*	-1.93	-148.8***	-4.06
No. of observations	417		523		408		624	
Wald test	17088.18***		955.31***		128900.28***		46.4***	
Hansen test (p-value)	0.315		0.637		0.198		0.524	
AR(1) (p-value)	0.095		0.003		0.007		0.016	
AR(2) (p-value)	0.386		0.148		0.11		0.744	

Notes: all explanatory variables are lagged by a one year period to address the potential endogeneity problem. The Hansen test is the test for over-identifying restrictions in the GMM dynamic model estimation. AR(1) and AR(2) refer to the Arellano-Bond test that average autocovariance in residuals of order 1 respectively of order 2 is 0. *, **, *** represent 10, 5, 1 percent significance levels, respectively.

Table 8 test of autocorrelation for the residuals

Cumby-Huizinga test for autocorrelation

H0: Disturbance is MA process up to order q

H1: serial correlation present at specified lags>q

Credit risk

Lag	Chi2	p-value
1	3.87	0.095
2	0.28	0.386

Liquidity risk

Lag	Chi2	p-value
1	8.86	0.003
2	0.37	0.148

Capital risk

Lag	Chi2	p-value
1	7.38	0.007
2	0.35	0.11

Insolvency risk

Lag	Chi2	p-value
1	4.48	0.016
2	0.15	0.744

Table 9 The impact of competition on risk-taking behaviour across different bank ownerships

Variable	Dependent variable: credit risk		Dependent variable: liquidity risk		Dependent variable: capital risk		Dependent variable: stability inefficiency	
	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat
Independent variables								
Lag of dependent variable	0.22***	25.95	0.15**	2.44	0.2***	11.88	-0.38***	-2.91
Diversification	0.001***	2.97	-0.015*	-1.81	-0.002**	-2.00	-0.05**	-2.37
Overhead	32.11***	8.85	-11.13**	2.48	-4.08*	1.81	10.44	0.96
Bank size	-0.18***	-5.15	-0.51***	4.44	-0.12***	5.88	-0.07**	-2.48
Inflation	-0.09***	-11.18	-0.002	-0.35	0.01***	7.77	0.01*	1.82
State-owned* Lerner	-0.525***	-2.05	-2.22**	2.19	-0.94***	-2.88	13.6**	2.33
Joint-stock* Lerner	-0.41***	-6.02	-3.18***	-2.68	-0.92***	-2.65	12.38**	2.29
City*Lerner	-1.23***	-5.58	-3.97***	-3.06	-1.21***	-3.88	12.7**	2.28
Constant	1.41***	6.77	-7.34***	-4.26	0.27	0.71	-10.3**	-2.23
No. of observations	417		523		408		624	
Wald test	1338.39***		212.34***		1132.65***		25.3***	
Hansen test (p-value)	0.335		0.489		0.248		0.202	
AR(1) (p-value)	0.093		0.003		0.003		0.007	
AR(2) (p-value)	0.377		0.215		0.375		0.230	

Notes: all explanatory variables are lagged by a one year period to address the potential endogeneity problem. The Hansen test is the test for over-identifying restrictions in the GMM dynamic model estimation. AR(1) and AR(2) refer to the Arellano-Bond test that average autocovariance in residuals of order 1 respectively of order 2 is 0. *, **, *** represent 10, 5, 1 percent significance levels, respectively.

Figure 1 Competitive conditions among three different ownerships of Chinese banks: 2003-2013

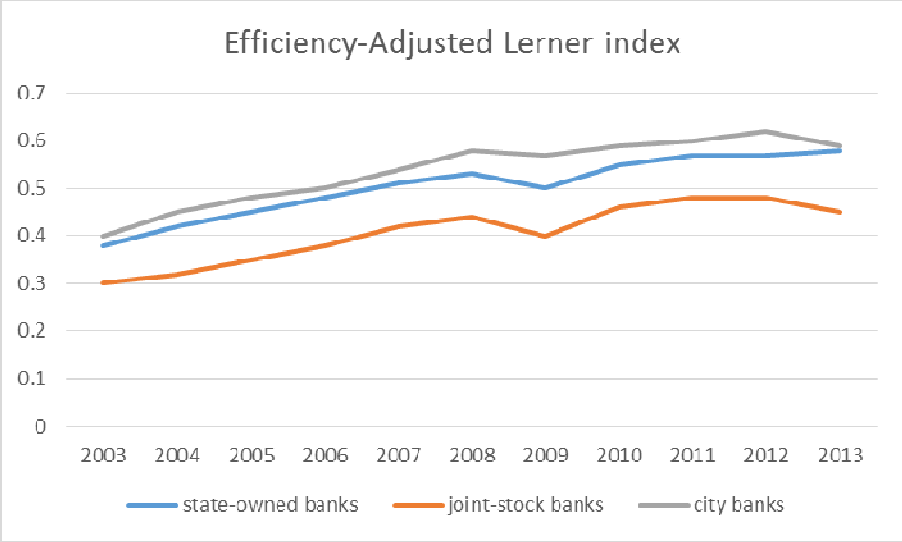


Figure 2 Risk conditions in the Chinese banking industry: 2003-2013

Figure 2a Credit risk in the Chinese banking industry: 2003-2013

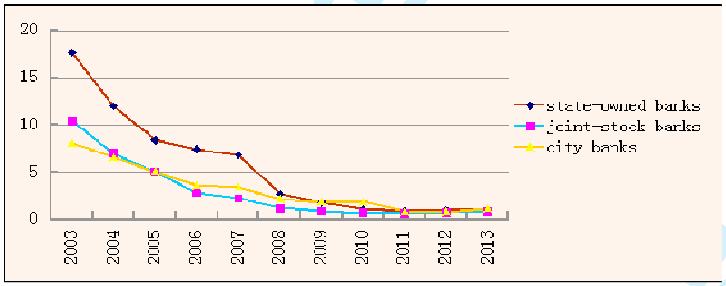


Figure 2b Liquidity risk in the Chinese banking industry: 2003-2013

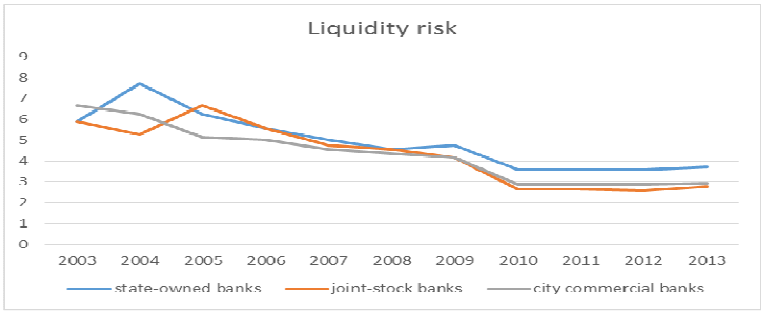


Figure 2c Capital risk in the Chinese banking industry: 2003-2013

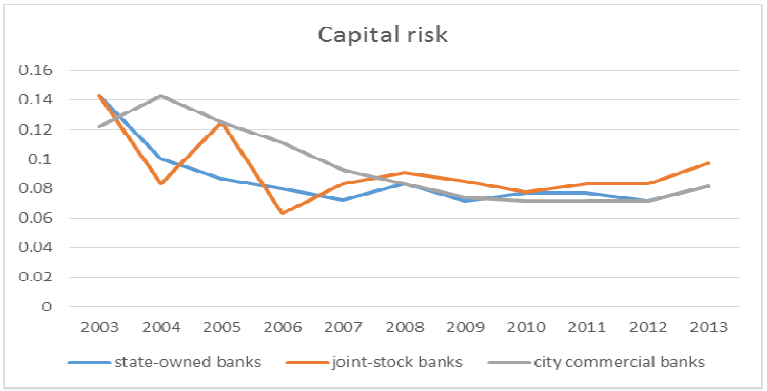
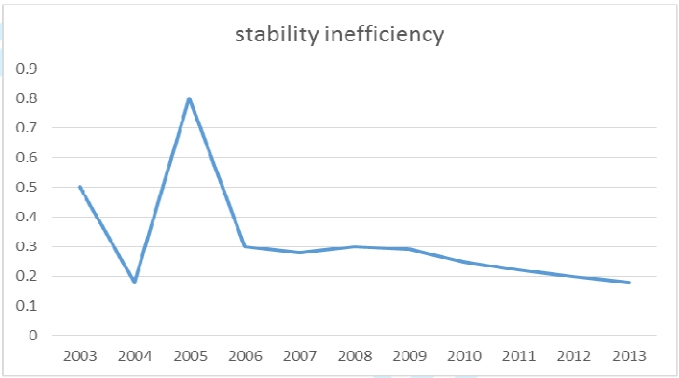


Figure 2d Insolvency risk (stability inefficiency) in the Chinese banking industry: 2003-2013



Revision on Paper in IJMF-06-2016-0115.R1

Dear Editor

We are grateful to you and the reviewer for your thoughtful reports as well as thorough and valuable comments, and are grateful for the opportunity to respond to your comments. In the following, we outline the revisions made in response to all comments. By all means the paper benefited considerably from all comments received.

1/ Notation and typos:
1A/ Indicate the ln(..)-function without ambiguity in all equations (despite Tabak's as there the formula are victims of the restricted layout of the Journal). LNNPI in (4) is not readable.

Response: Thank you very much for this comment. Please see equation 2 and equation 4 for detail.

1B/ The indices (it) are missing in (3) for W2 on the left hand side, and for LN(W1/W2) on the right; the index (t) at T in (2) and (4).

Response: Thank you very much for this comment. This comment has been carefully addressed, please see equations 2, 3, and 4 for detail.

1C/ In (4) there should be an exponent of 2 at (1/2) beta2 ln(W1/W2): (1/2) beta2 ln(W1/W2)^2 .

Response: Thank you very much for this comment. This issue has been addressed carefully in the revised manuscript. Please see equation 4 for detail.

1D/ Dummy should be written also as "Dummy" in (4). In front of Ln(NPI) there should be a coefficient parameter. The notation of Tabak et al. by just writing "…+ Dummies + …" is appealing.

Response: Thank you very much for this comment. We have carefully revised the equation 4 to address this point.

2/ Cost function (2), marginal cost (3), Z-score function (4), Tab. 6, Tab. 8:
2A/ p.9, l.33: Augment the different output types with the associated abbreviation Y_1, etc.
p.9, l.47: T should be written with index t in (2).

Response: Thank you very much for this comment. This issue has been carefully addressed in the manuscript by clearly identifying four different outputs. Please see the first two lines under equation 2 for detail. In addition, an index t has been added after T in equation 2.

2B/ Three types of banks are considered, with possibly different intercepts. But only two parameters are given, and none of them is commented.
Either 3 dummies, or 1 overall intercept and 2 dummies have to be included. If only two are reported then some of them are equal?
p.9, l.43 says that λ_0 represents bank-specific heterogeneity. Should it be read as λ_i?
As notation in (2) "Dummies" would be a choice, with an explanation in the text.

Response: Thank you very much for this comment. We carefully address this issue by including two dummies representing two different ownership types of Chinese commercial banks namely joint-stock commercial banks (JSCBs) and city commercial banks (CCBs). In addition, the explanation of Dummies has been provided in the manuscript. Please see the revised paragraph under equation 2.

2C/ In Tab. 8, e.g., 2 dummies (for JSCB, CCB) and a Constant are included. Here as reference the SOCBs (Constant) are chosen and the estimated coefficients are the difference (relative position) to the SOCB-Constant.

Response: Thank you very much for this thoughtful comment. We have added this statement to the manuscript. Please see line 14 on page 12 for detail.

2D/ Estimation of (4), Tab. 6:
As Tabak et al. have not included their estimated stochastic frontier, a footnote indicating that the estimation results can be requested from the authors should be enough.
[Nevertheless, the bank-type dummies have to be checked. Further, there are 3 outputs but only one coefficient delta_j, similarly for delta_jk and theta_j ?]

Response: Thank you very much for this comment. The footnote has been added in the manuscript indicating that the estimation results can be requested from the authors. Please see footnote 8 on page 11 for detail.

3/ Marginal costs (3):
The indices (it) are missing at ((C/W2)/Y) and ln(W1/W2)

Response: Thank you very much for this comment. The equation 3 has been carefully revised according to this comment.

4/ Z-score function (4):

In Tabak et al. p.3370, left col., l.7 from bottom, says that the Z-score is inversely proportional to the bank's probability of default.
4A/ So I am not sure whether you make it clear enough in the middle of p.10, that the explanatory part of the right hand side of (4) describes the maximal Z-score (so the least inefficiency/probability of default). A bank is highly inefficient/highly likely to default, if it has a very low Z-score, or ("maximal Z-score" – "Z-score of bank i") is large. A bank type is on average highly inefficient, if the mean of υ, μ, for that bank type is large.
[You use exactly the same error structure as Tabak et al.]

Response: Thank you very much for this comment. This suggested statement has been added in the manuscript. Please see the last paragraph on page 10 for detail.

4B/ Could you also state how you calculate the inefficiency. (Cp. (7) in Tabak et al.)

Response: Thank you very much for this comment. Please see the last sentence of the paragraph under equation 4 on page 11 for detail.

5/ If it is found to be empirically necessary that dummies for the bank type have to be included to distinguish different intercepts, then the maximal Z-score function is that of the bank type with the largest intercept.
5A/ If different bank types are distinguished in (4) by dummies the maximal Z-score is determined by the largest intercept. So, average inefficiency of a bank type is calculated by adding the difference of the intercepts (largest intercept and intercept of the bank type in question) plus μ of the bank type in question.
Clearly, different dummies in the level and/or different μ's could be used.
So the mean of μ is either a constant, or depends only on the bank type, or on i if a bank specific efficiency is calculated. But not on i and t.

Response: Thank you very much for this comment. Two ownership type dummies representing joint-stock commercial banks and city commercial banks have been included in equation 4.

6/ Last sentence of 4.2 might be misunderstood, so omit.
p.11, l.35 should read as: In equation (5), …
p.11 l.47: delta_{i,t-1} should read as alpha_{i,t-1}.
Tab. 8 last column: -148.83 should read as -148.8***.

Response: Thank you very much for this comment. All these three points have been carefully revised in the manuscript.