**Risk, competition and cost efficiency in the Chinese banking industry**

**Yong Tan* and Christos Floros****

***corresponding author: Department of Accountancy, Finance and Economics, Huddersfield Business School, University of Huddersfield, Huddersfield, Queensgate, HD1 3DH, UK.**

**Email: a.y.tan@hud.ac.uk**

****Department of Accounting and Finance, Technological Educational Institute of Crete, Heraklion, Greece and Hellenic Open University – School of Social Sciences, Patras, Greece**

**Email: cfloros@staff.teicrete.gr**

## Abstract

Using a sample of Chinese commercial banks over the period 2003-2013, this paper tests the interrelationships between credit risk, competition and cost efficiency in the Chinese banking industry under a three-stage least square estimator. The findings suggest that a higher level of competition leads to higher credit risk of Chinese commercial banks and a higher level of efficiency leads to lower credit risk. In addition, it is found that higher level of efficiency results in higher level of competition in the Chinese banking industry and higher levels of credit risk precede an increase in the level of competition. Finally, the results show that Chinese commercial banks with higher levels of credit risk have lower levels of cost efficiency and competition-efficiency hypothesis holds in the Chinese banking industry. The results provide policy implications to the Chinese government and banking regulatory authorities.

**Key words: credit risk, competition, cost efficiency, Chinese banking, three-stage least square**

**JEL classification: G21, C33, C14**

## 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 banking reforms has been to increase competitive conditions, enhance stability and improve the performance of the Chinese banking sector. State-owned commercial banks (SOCBs) dominated 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%, while the joint-stock commercial banks (JSCBs) and city commercial banks (CCBs) kept increasing in size and in 2013 they hold 17.8% and 10.03% of total banking sector assets. This shows that competitive conditions in the Chinese banking sector have increased significantly.

In order to solve the problem of higher volumes of non-performing loans, four Assets Management companies were established in 1999 and China Banking Regulatory Commission was established in 2003 to further monitor and manage the risk-taking behaviour of Chinese commercial banks and protect the interest of depositors (Tan and Floros, 2012). The Chinese banking industry has reduced its credit risk undertaken over the period 2003-2013. Non-performing loan ratios over the period 2011-2013 kept at 1% which was lower than the figures for 2008-2010.

There were few pieces of research investigating competitive conditions in the Chinese banking sector (Yuan, 2006; Masood and Sergi, 2011; Fu, 2009; Park, 2013; Tan and Floros, 2013a; Tan, 2014), There were also a number of studies examining the effect of competition on risk-taking behaviour in banking industry (Agoraki et al., 2011; Fu et al, 2014; Beck et al., 2013; Schaeck and Cihak, 2014; Anginer et al., 2014; Liu and Wilson, 2013; Liu et al., 2013; Liu et al., 2012; Soedarmono et al., 2013), however, there were very few studies testing the impact of competition on risk-taking behaviour in the Chinese banking industry (Tan and Floros, 2013b; Tan and Floros, 2014; Tan, 2014). Several rounds of banking reforms in China not only aimed to improve the competitive condition and reduce the risk-taking behaviour of Chinese commercial banks but improved the performance in the Chinese banking industry.

There were a number of empirical studies examining the performance of Chinese commercial banks (Garcia-Herrero et al., 2009; Tan and Floros, 2013a; Sun et al., 2013; Liang et al., 2013; Tan, 2014). In particular, Tan and Floros (2013a) tested the inter-relationships between risk, capital and efficiency in the Chinese banking industry. Although the study examined the relationship between risk and efficiency, there is no study examining the interrelationships between risk, competition and efficiency in the Chinese banking industry. The investigation on this issue will provide valuable information to Chinese banking regulatory authorities in order to make relevant policies to further improve the performance of Chinese commercial banks. The current paper fills the gaps of empirical literature by being the first paper to investigate the inter-relationships between risk, efficiency and competition in the Chinese banking industry.

The findings suggest that a higher level of competition leads to higher credit risk of Chinese commercial banks and a higher level of efficiency leads to lower credit risk. In addition, it is found that a higher level of cost efficiency results in a higher level of competition in the Chinese banking industry and higher levels of credit risk precede an increase in the level of competition. Finally, the results show that Chinese commercial banks with higher levels of credit risk have lower levels of cost efficiency and competition-efficiency hypothesis holds in the Chinese banking industry. This paper has the following structure: Section 2 reviews relevant literature on the interrelationships between risk, competition and efficiency in the banking sector. Section 3 presents the methodology, while section 4 presents the data and discusses relevant results. Finally, section 5 concludes the paper.

## 2. Literature review

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

Competition-fragility hypothesis argues that banks have the ability to withstand shocks and decrease risk-taking behaviour due to the fact that in a less competitive environment, banks are able to earn higher profitability through monopoly rents (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) suggested 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, there is still no consensus regarding the issue of whether competition precedes bank stability or fragility.

The bad management hypothesis (Berger and DeYoung, 1997) suggests that lower level of efficiency leads to higher costs because banks do not monitor the credit adequately and also they do not control the expenses efficiently. The declines in efficiency will result in increases in banks' risk because of credit, operational, market and reputational problems. However, the moral hazard hypothesis (Jeitschko and Jeung, 2005) argues that banks with lower levels of efficiency tend to take higher risk. The moral hazard problem arising from the presence of informational friction and the existence of agency problem will make bank managers take on higher risk.

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

The main argument regarding the impact of risk on market power suggests that banks with higher ability to manage the risk conditions will increase the profit-cost margin and further increase the market power (Fernandez de Guevara and Maudos, 2007). The impact of efficiency on competition is mainly documented in the efficient-structure hypothesis (Demsetz, 1973). The hypothesis argues that performance plays a decisive role in the structure. To be more specific, this theory suggests that banks with higher levels of efficiency gain market share at the expenses of less efficient banks, so the concentration increases and the competitive conditions reduce.

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

Competition-inefficiency hypothesis suggests that competition leads to a decline in bank efficiency for the following reasons. First, Boot and Schmeits (2005) argued that the relationships between customers and banks are less stable and shorter in a higher competitive environment. Furthermore, higher bank competition increases customers' propensity to switch to other service providers. This phenomenon will amplify the information asymmetries and requires additional resources for screening and monitoring borrowers. Second, Chan et al. (1986) argued that in a competitive environment, there is a shorter

duration of bank relationships, the reduction of relationship-building activities inhibits the reusability and value of information. The competition-efficiency hypothesis (Zarutskie, 2013) argues that higher competition induces banks to specialise and focus on certain types of loans or particular groups of borrowers. It will also induce bank managers to adjust their lending technologies. The banks are able to lower the costs of processing and originating loans and better monitor the borrowers. This positive impact is in line with the "Quiet Life hypothesis" which suggests that managers with monopoly power enjoy a share of monopoly rents; they are careless in the expense management which leads to a decline in efficiency. The bad luck hypothesis (Berger and DeYoung, 1997) shows that risk has a significant impact on efficiency. The hypothesis suggests that increase in problem loans for the banks is mainly attributed to the external events rather than manager's skills or their risk-taking appetite. The increase in risk incurs additional costs and managerial efforts. Thus, increase in risk precedes a decline in bank efficiency.

**2.4 The interrelationships between risk, competition and efficiency in the banking industry**

In the empirical literature, there were very few studies testing the inter-relationships between 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 et al. (2011) examined these inter-relationships under Generalized Method of Moments estimators. The findings show that the competition in investment banking worldwide is quite limited. Although relatively low competitive pressures are helpful in enhancing banks' stability, the results report that banks tend to undertake higher risk in a lower competitive environment. Their findings show that competition-stability paradigm holds for the investment banking industry.

Using a sample of 272 commercial banks from 15 Latin American countries for the period 2001-2008, Kasman and Carrallo (2014) tested the inter-relationships between competition, risk and efficiency under a granger causality technique. The results show that higher competition leads to greater financial stability, while banks with higher stability enjoy higher market power, also banks with higher market power have higher efficiency.

In summary, the empirical banking literature has not investigated the interrelationships between risk, competition and efficiency very well, while there is no study examining this issue in the Chinese banking sector. This topic is particularly important for the Chinese banking industry due to the fact that several rounds of banking reforms in China have aimed to reduce the risk, improve the performance and increase the competitive conditions among Chinese commercial banks (Tan, 2016). The investigation of this issue will provide more policy implications to the Chinese government as well as the banking regulatory authorities. To be more specific, the current paper contributes to the empirical literature in the Chinese banking industry by testing the inter-relationships between these three factors. The findings will be helpful for the Chinese government to enhance the stability of Chinese commercial banks.

## 3. Methodology

### 3.1 Estimation of competition in the Chinese banking sector-Lerner index

During recent years, a number of research articles used different methods to investigate competitive condition in the banking industry including k-bank concentration ratio, Herfindahl-Hirschman index, Panzar-Rosse H statistic, Lerner index as well as Boone indicator (Al-Muharrami et al., 2006; Matthew 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).

Although there are a number of researchers using Panzar-Rosse H statistic to investigate competition in the banking sector, it mainly suffers from two drawbacks. First, Leuvensteijn et al. (2011) argued that the H statistic is based on a static model, and there are no predictions on the H-statistic which is one of the weaknesses of this test. In other words, the estimate is suffered from a degree of uncertainty. Furthermore, Claessens and Laeven (2004) argued that because of market entry and exit, it cannot fulfil the requirement of overall market equilibrium, which leads to further limits on the interpretation of such analysis.

Furthermore, the Boone indicator also suffers from two disadvantages. First, Tabak et al. (2012) argued that the Boone indicator makes the assumption that banks pass part of the efficiency gains onto consumers. In addition, this indicator also suffers from idiosyncratic variation, i.e. uncertainty.

The current study uses Lerner index to measure competition in the Chinese banking industry mainly because of the following reasons: 1) Lerner index provides the market power of each bank in a specific year; and also it matches with its determinants, which are bank-level variables at each year; 2) Lerner index can estimate the competitive conditions (market power) for three different ownership types of Chinese banks.

The Lerner index is defined as the difference between a bank's price and the 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 less competition. The Lerner index represents the extent to which a particular bank has the market power to set its price above the marginal cost.

The average price of bank production (proxied by total assets) as the ratio of total revenue to total assets measures the price; this measurement follows the studies of Fernandez de Guevara et al. (2005) and Carbo et al. (2009). Further, a translog cost function with three outputs and two input prices measures the marginal cost. The cost function has the following form:

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

(1)

where C represents the total cost of a bank, Y represents three outputs including total loans, non-interest income and securities, and W stands for two input prices with $W_1$ representing the price of funds which is measured by the ratio of interest expenses to total deposits. $W_2$ 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 Marton, 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. The linear homogeneity is ensured by normalising 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:

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

Table 1 summarizes the variables used to estimate the Lerner index.

<<Table 1---about here>>

### 3.2 Estimation of cost efficiency in the Chinese banking industry

There are mainly two approaches which are widely used in estimating bank efficiency; they are Stochastic Frontier Approach (SFA) and Data Envelopment Analysis (DEA). The main argument for using the DEA rather than 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 showed that using DEA to estimate the efficient frontier can yield robust results (Seiford and Thrall, 1990). However, although DEA has a few advantages compared to SFA with regard to the efficiency estimation, it also suffers from a number of disadvantages. First and foremost, DEA does not assume statistical noise, which means that the error term in the estimation is attributed to inefficiency. Therefore, the influence of a number of factors such as bad data, luck and extreme observations is accounted as inefficiency in DEA. Secondly, Sun and Chang (2011) further argued that measuring DEA in small samples is sensitive to the difference between the number of firms and the sum of inputs and outputs used. Fries and Taci (2005) argued that the SFA is more appropriate over the DEA in efficiency studies in developing countries where problems of measurement errors and uncertain economic environment are more likely to prevail. Therefore, the current study uses the SFA to estimation cost efficiency in the Chinese banking industry. The efficiency level can be estimated by specifying the commonly-used translog functional form for the cost function. The cost function will be the same as equation (1), while an additional equation has been added to separate the error term into two components as follows:

$$\varepsilon_{it} = v_{it} + u_{it} \qquad (3)$$

Where $V_{it}$ is a two-sided normal disturbance term with zero mean and variance $\sigma_v^2$ and represent the effect of statistical noise, and $U_{it}$ is a non-negative random disturbance term capturing the effects of inefficiency. Table 2 shows the summary statistics of the variables used to measure the cost efficiency of Chinese commercial banks.

<<Table 2---about here>>

### 3.3 Estimation on the interrelationships between risk, competition and efficiency

The current study specifies a system of equations and the estimation of theses equations is under a three-stage least square estimator to deal with the endogeneity issue[1]. The system of equations has the following form:

$$RISK_{it} = a_1 + b_1 EFFICIENCY_{it} + c_1 competition_{it} + d_1 size_{it} + e_1 SMD_t + f_1 JSCBs_{it} + g_1 CCBs_{it} \quad (4)$$

$$competition_{it} = a_2 + b_2 efficiency_{it} + c_2 risk_{it} + d_2 size_{it} + e_2 GDPG_t + f_2 JSCBs_{it} + g_2 CCBs_{it} \quad (5)$$

$$efficiency_{it} = a_3 + b_3 competition_{it} + c_3 risk_{it} + d_3 size_{it} + e_3 profit_{it} + f_3 JSCBs_{it} + g_3 CCBs_{it} \quad (6)$$

Where subscript i and j represent specific bank operating at a specific year, and RISK represents credit risk. Efficiency is cost efficiency scores derived from the stochastic frontier approach, while the competition is the competition indicator (the Lerner index). The simultaneous equations also control for various other variables influencing the risk, competition and efficiency relationships. They are bank size, bank profit, stock market development and annual GDP growth rate. Finally, we also control for two bank-ownership dummies variables which are joint-stock commercial banks (JSCBs) and city commercial banks (CCBs).

[1] We test the endogeneity issue by using the approach by Smith and Blundell (1986). The results indicate that there are three variables suffered from endogeneity which include credit risk, cost efficiency and competition.

Large banks are able to reduce costs from economies of scale and scope, so the cost reduction precedes an improvement in efficiency. At the same time, large banks face diseconomies because of managerial inefficiencies; hence, we do not have any a priori expectation of the impact of size on bank efficiency. Further, we do not have any a priori expectation regarding the impact of profitability on efficiency. The profitable banks are more able to control all aspects of costs which leads to higher efficiency (Girardone et al., 2004). However, managers in a bank with higher profitability normally have less incentive and make less effort in monitoring and managing the cost, which leads to lower efficiency. Higher developed banking market indicates that the demand for banking services is large, due to the fact that it is quite difficult for new banks to enter the market; hence, the relatively short supply in related to the increase in demand lifts up the prices for banking services. The resulted improvement in bank profitability induces bank managers to be less careful in control the costs, which precedes a decline in bank efficiency. Therefore, the current study expects that this variable has a significant and negative impact on bank efficiency. With regard to the impact of bank size on bank competition, the current paper further expects that the impact of bank size on Lerner index is significant and positive (Fernandez de Geuvara et al., 2005). We also expect that GDP growth has a positive impact on Lerner index (Maudos and Fernandez de Guevara, 2011). In other words, the competition is expected to be lower during the periods of economic boom.

In terms of the impacts of different variables on risk conditions in the Chinese banking industry, it is argued that, because of the consideration of too big to fail, the managers in a large bank have less incentive in monitoring and managing the risk. However, larger commercial banks have a longer history, and therefore, are expected to have more comprehensive knowledge and expertise in managing the risk. Thus, we do not have any a priori expectation with regard to the impact of size on bank risk. Moreover, stock market development is supposed to influence the risk of Chinese banks positively. Higher developed stock market reduces the volumes of business engaged in by banks. To increase the volumes of business and further increase their revenues, the banks tend to increase the risk-taking behaviour. Table 3 provides the summary of the variables used in the current study.

<<Table 3---about here>>

One important aspect of the three-stage least square estimation is the use of instrumental variables in the model. The current study uses three instrumental variables which are activity restrictions, financial freedom and property rights. To be more specific, activity restrictions mainly measure the degree to which banks are allowed by the banking regulatory authorities to engage in non-interest income generating activities. In other words, this indicator measures the government restrictiveness on banks' activities in the securities market, insurance market and real estate industry. The value of this indicator ranges from 4 to 16, with higher values indicating a higher degree of restrictiveness. Financial freedom measures the degree of openness of a financial system. This indicator reflects the degree of involvement of the country's government in the operation of the financial system. The areas considered by this indicator include the government regulation. Financial products and allocation of credit, freedom of foreign banks to operate in the domestic market as well as the degree of regulation of financial market activities. The value of this indicator ranges from 0% to 100%, with higher values indicating a higher degree of financial freedom. Finally, the fundamental basis of a well-functional financial system is the protection of property rights, the value of this indicator ranges from 0 to 100, with higher values indicating weaker protection of property rights[2]. With regard to the data source of the instrumental variables, activity restrictions are collected from World Bank survey of bank regulation and supervision, while financial freedom and property rights are obtained from Heritage Foundation (2013). The selection of the instrumental variables follows Fu et al., (2014).

**4. Data and Empirical results**

The banking data includes 100 Chinese commercial banks (5 SOCBs, 12 JSCBs and 83 CCBs) over the period 2003-2013. With regard to the data sources, the current study collects the data of bank-specific variables from Bankscope, while the industry-specific variables and macroeconomic variables are from the CBRC annual reports as well as the World Bank database. Table 4 shows the summary statistics of the variables used in the current study. The results show that the difference in credit risk undertaken by

[2] The exogeneity of the instruments have been tested using the Hausman test. The results of the test show that we cannot reject the null hypothesis. In other words, we find that the instruments are exogenous and not correlated with the error term. The results are not reported in this paper, however, they are available from the corresponding author upon request.

Chinese commercial banks is bigger than the ones of profitability achieved. While higher levels of credit risk undertaken by Chinese commercial banks is attributed to the fact that during 2003-2006, there are large volumes of non-performing loans in SOCBs especially in the Agricultural Bank of China. The difference in bank size is attributed to the fact that SOCBs is bigger than JSCBs, while CCBs is the smallest. The results further show that there is a stronger volatility with regard to the stock market development compared to other variables considered in the current study. The stronger volatility of stock market development can be mainly attributed to the segregation reform initiated by the Chinese government in 2005 which leads to a substantial amount of companies listed on stock exchange. By the end of 2007, there are 1550 listed companies in Shanghai and Hong Kong stock exchanges, the value of which reaches RMB 32.71 billion, accounting for 132,6% of GDP at that year, while the stock market development is in its early stage before 2005.

<<Table 4--about here>>

**4.1 Credit risk in the Chinese banking industry**

Figure 1 shows that, over the period 2003-2008, the credit risk of SOCBs was substantially higher than the ones of JSCBs and CCBs, while large volumes of non-performing loans in SOCBs was mainly attributed to the fact that one of the banks (the Agricultural Bank of China) had non-performing loan ratios of over 23% over the period 2003-2007. Although the figure shows that, after 2008, all the three different ownership types of Chinese commercial banks had little difference with regard to the levels of credit risk undertaken, the credit risk of CCBs was still higher than the one of the JSCBs between 2005 and 2010. The lowest credit risk of JSCBs in China was mainly attributed to the fact that the participation of foreign investors in domestic JSCBs improved the techniques of risk management and further preceded a decline in credit risk. The significantly lower levels of credit risk for all three different ownership types of Chinese banks after 2008 were attributed to the financial crisis, which induced the government and banking regulatory authorities to improve the process of credit checking, risk monitoring and risk management.

<<Figure 1---about here>>

### 4.2 Competitive conditions in the Chinese banking industry

Figure 2 shows the competitive conditions of the Chinese banking industry over the examined period. They are presented for all three different ownership types. It is observed that the minimum value of the Lerner index is 0.38, while the highest value is nearly 0.6. A comparison of these values with the values of the Lerner index from other countries shows that Chinese commercial banks had 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 ranged from 11% to 22%, while for developed countries the average value of the Lerner index for the banking sectors was 22% (Berger et al., 2009). Fungacova et al. (2010) show that the value of the Lerner index for the Russian banking sector was 21.4%. These comparisons show that competition in the Chinese banking industry was very low.

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

<<Figure 2---about here>>

### 4.3 cost efficiency in the Chinese banking industry

Figure 3 reports the results on the cost efficiency of three different ownership types of Chinese commercial banks over the examined period. It is noticed from the figure that city commercial banks had the highest cost efficiency, which is followed by state-owned commercial banks. Further, the joint-stock commercial banks had the lowest efficiency over the examined period. Figure 4 shows the results with regard to the cost efficiency of three different ownership types of Chinese commercial banks on an annual basis. The findings show that the cost efficiency of Chinese commercial banks was quite stable over the early period examined (2003-2007), while the difference in the cost efficiency among these three different ownership types of Chinese commercial banks was observed over the period 2008-2013.

<<Figure 3---about here>>

<<Figure 4---about here>>

**4.4 The interrelationships between risk, competition and efficiency in the Chinese banking industry**

Before estimating the inter-relationships between risk, competition and efficiency in the Chinese banking industry, we test the correlation between all the variables to see whether there is a multicollearality problem; the results of which is reported in Table 5. The findings suggest that there is no multicollinearity problem as all the figures are less than 0.8 (Kennedy, 2008).

<<Table 5---about here>>

Table 6 presents the results on the inter-relationships between credit risk, competition and cost efficiency in the Chinese banking industry. The findings show that higher competition in the Chinese banking industry leads to high credit risk undertaken by the Chinese commercial banks. This finding is in line with the competition-instability hypothesis. While in terms of the impact of competition on efficiency in the Chinese banking industry, the results report that higher competition in the Chinese banking industry precedes an increase in cost efficiency of Chinese commercial banks. This result is in accordance with the competition-efficiency hypothesis. The findings further report that higher credit

risk undertaken by the Chinese commercial banks increases the competitive condition in the Chinese banking industry. This is in different contrast with the finding of Fernandez de Guevara and Maudos (2007). This result is attributed to the fact that higher credit risk undertaken by the Chinese commercial banks significantly increase the cost, while the resulted decrease in the price-cost margin leads to lower market power and higher competition. Regarding the interrelationships between cost efficiency and credit risk, the findings suggest that higher credit risk leads to lower cost efficiency. The results are in accordance with the bad luck hypothesis. The findings show that Chinese commercial banks with a higher level of cost efficiency have lower credit risk. This is in line with the bad management hypothesis and moral hazard hypothesis[3].

<<Table 6---about here>>

## 5. Conclusion

This study significantly contributes to the existing empirical studies in the Chinese banking industry by investigating the inter-relationships between credit risk, cost efficiency and competition using data of three different ownership types of Chinese commercial banks (state-owned commercial banks, joint-stock commercial banks and city commercial banks) over the period 2003-2013.

The findings suggest that higher level of competition leads to higher credit risk of Chinese commercial banks and a higher level of efficiency leads to lower credit risk. In addition, it is found that a higher level of efficiency results in a higher level of competition in the Chinese banking industry and higher levels of credit risk precede an increase in the level of competition. Finally, the results show that Chinese commercial banks with higher levels of credit risk have lower levels of cost efficiency and competition-efficiency hypothesis holds in the Chinese banking industry.

The results of the current paper provide a number of policy implications to Chinese banking regulatory authorities as follows: 1) Chinese commercial banks should further enhance the process of credit

[3] The robustness of the results has been cross checked by using different competition, efficiency and credit risk indicators. To be more specific, the Hirfindahl-Hirschman index has been used as the alternative competition indicator, efficiency has been measured by the ratio of overhead to total assets, while the credit risk has been cross checked by using the ratio of loan loss provision to total loans. The results are quantitatively similar to the original estimation. The results are available upon request from the corresponding author.

checking, monitoring and management to reduce the volumes of non-performing loans; and 2) relevant policies to regulate the competitive conditions in the Chinese banking industry should be carefully considered to balance the increase in the level of credit risk and increase in the level of efficiency derived from a higher level of competition. Further research should examine the above hypotheses using recent methods and data from other Asian countries.

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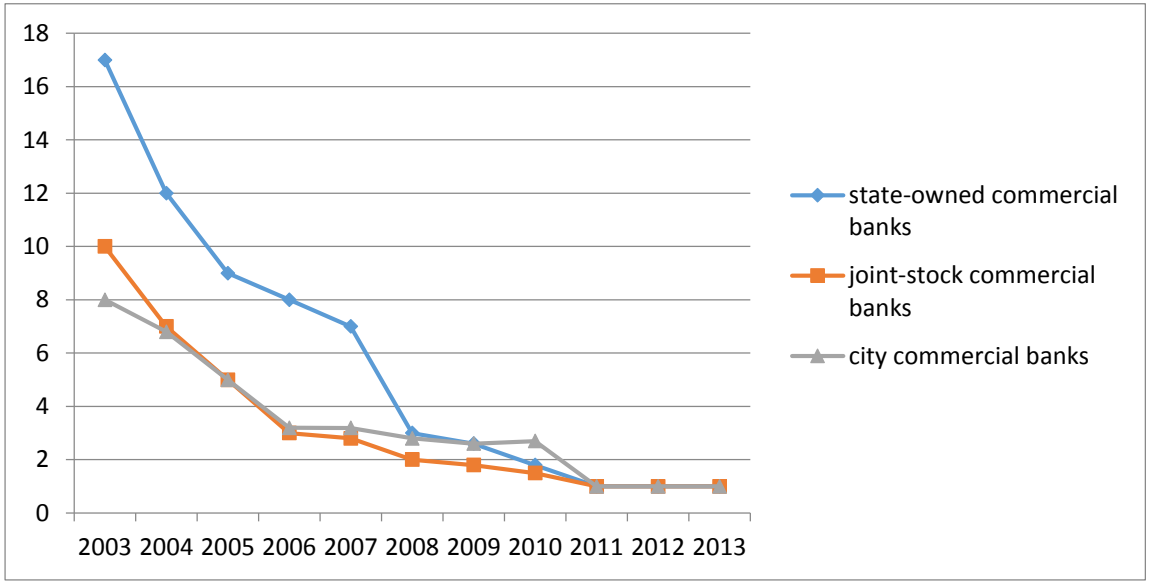
**Figure 1 Credit risk in the Chinese banking industry**




Notes: the horizontal axis represents different years, while the vertical axis represents the percentage of non-performing loans.

**Figure 2 Competitive condition in the Chinese banking industry**

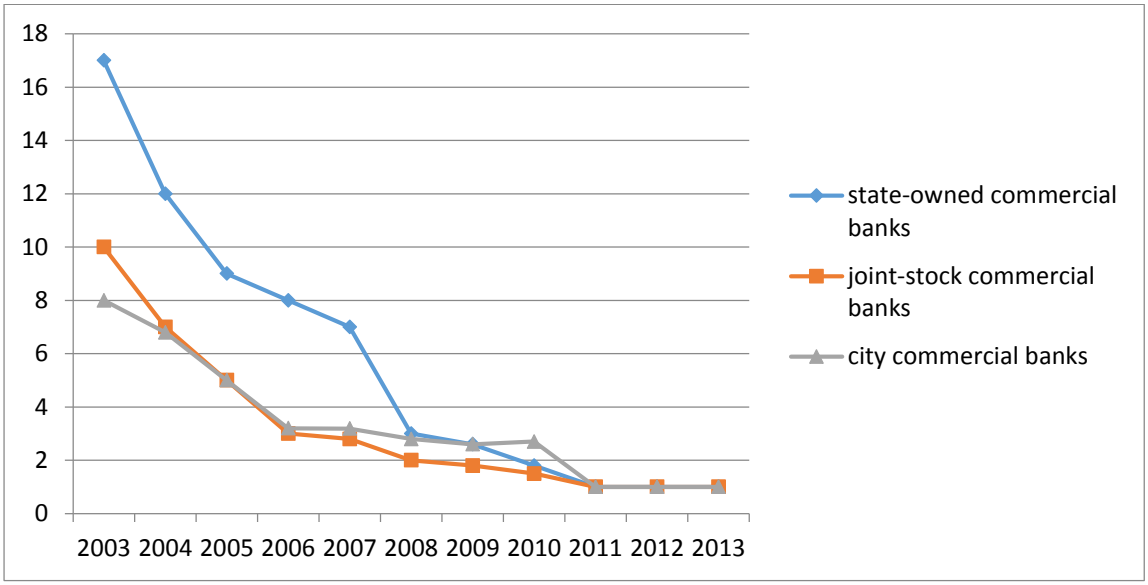


**Table 1 Definition of the variables used to estimate the Lerner index**

| Variable | Notation | Measurement |
|---|---|---|
| Total cost | COST | Interest expenses plus non-interest expenses |
| outputs | Y | Total loans<br>Securities<br>Non-interest income |
| Input prices | W | Input price 1: price of fund-ratio of interest expenses to total deposits<br><br>Input price 2: price of capital-ratio of other non-interest expenses to fixed assets |
| Marginal cost | MC | Estimated using equation 1 and equation 2 |

**Table 2 Summary statistics of inputs and outputs used to estimate the efficiency scores**

| Variables | observations | Mean | S.D | Min | Max |
|---|---|---|---|---|---|
| **Inputs** | | | | | |
| Total cost (interest expenses and non-interest expenses) | 1100 | 3.35 | 0.97 | -0.79 | 6.86 |
| Price of funds (the ratio of interest expenses over total deposits) | 1100 | 1.27 | 0.18 | 0.74 | 1.96 |
| Price of capital (the ratio of non-interest expenses over fixed assets) | 1100 | 1.92 | 0.26 | 0.68 | 2.83 |
| **Outputs** | | | | | |
| Total loans | 1100 | 4.59 | 0.99 | 0.34 | 7.95 |
| Securities | 1100 | 4.21 | 1.04 | -0.405 | 7.87 |
| Non-interest income | 1100 | 2.34 | 1.1 | -2.4 | 5.81 |

Notes: all the variables in this table are in natural logarithm and the unit of all the variables is million RMB, the price of funds and price of capital are in the format of percentage, while the variables involved in the calculation are measured by million RMB.

**Table 3 Description of the variables used in the study**

| Variables | Indicator | Definition |
|---|---|---|
| Risk | Credit risk | Ratio of non-performing loans to total loans |
| Competition | Lerner index | |
| Efficiency | cost efficiency | SFA |
| Bank-specific variables | | |
| Bank size | Size | Natural logarithm of total assets |
| Bank profitability | ROA | Return on Assets |
| Industry-specific variables | | |
| Stock market development | SMD | the ratio of market capitalization of listed companies to GDP |
| Macroeconomic variables | | |
| GDP growth | GDPG | Annual GDP growth rate |

**Table 4 Descriptive statistics of the variables used in the current study**

| Variables | Observations | Mean | S.D | Min | Max |
|---|---|---|---|---|---|
| Credit risk | 1100 | 2.78 | 4.48 | 0 | 41.86 |
| Bank profitability | 1100 | 0.009 | 0.007 | -0.04 | 0.106 |
| Bank size | 1100 | 4.9 | 0.992 | 0.71 | 8.51 |
| Stock market development | 1100 | 71.2 | 43.49 | 31.9 | 184.1 |
| GDP growth rates | 1100 | 10.19 | 1.87 | 7.7 | 14.2 |

Notes: all the variables in the above table are in the format of percentage, while in order to calculate the percentage, all the variables involved in the calculation are measured by million RMB, GDP growth rates are the statistics directly from World Bank.

**Figure 3 Cost efficiency of Chinese commercial banks by ownership types**

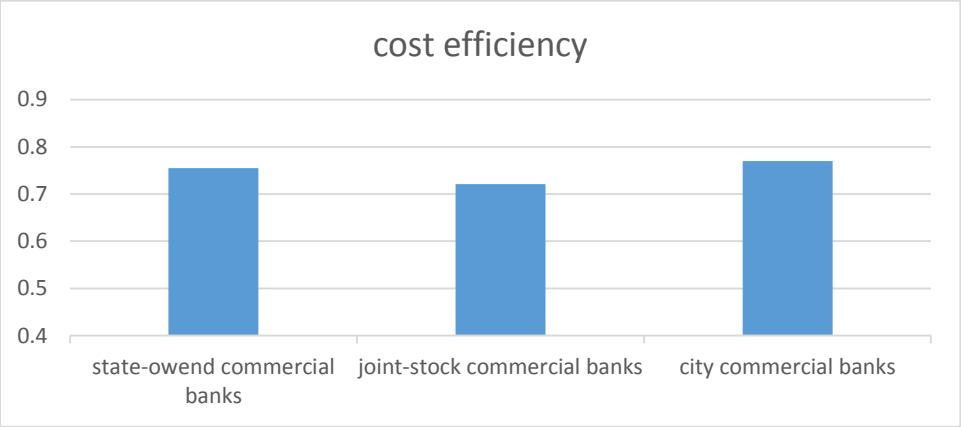
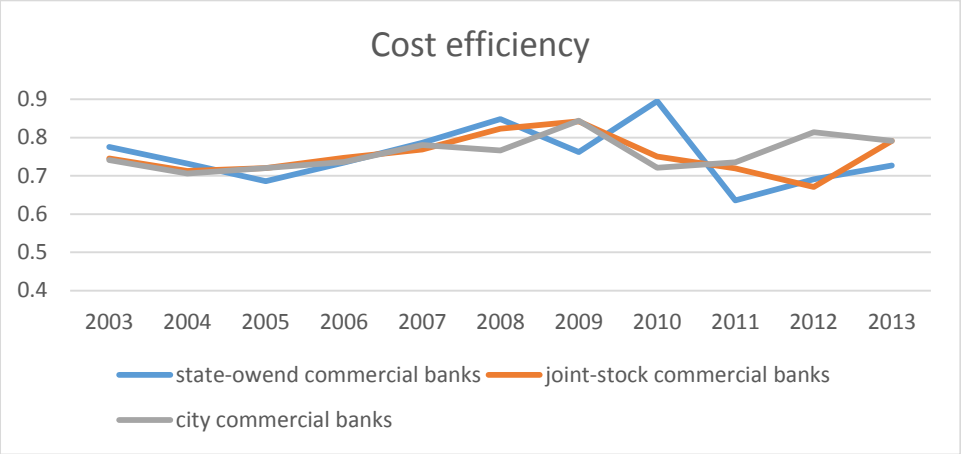


**Figure 4 Cost, revenue and profit efficiencies of Chinese commercial banks on annual basis**



| **Table 5 Correlation matrix** | **CR** | **CE** | **LI** | **SIZE** | **NTA** | **ROA** | **BSD** | **SMD** | **INF** | **GDPG** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CR** | **1** | | | | | | | | | |
| **CE** | **-0.05** | **1** | | | | | | | | |
| **LI** | **-0.19** | **0.08** | **1** | | | | | | | |
| **SIZE** | **-0.09** | **-0.06** | **0.15** | **1** | | | | | | |
| **ROA** | **-0.24** | **0.02** | **0.22** | **0.04** | **0.04** | **1** | | | | |
| **SMD** | **-0.01** | **0.45** | **-0.01** | **-0.22** | **-0.02** | **-0.04** | **-0.39** | **1** | | |
| **GDPG** | **0.18** | **-0.09** | **-0.11** | **-0.29** | **0.008** | **-0.18** | **-0.71** | **0.71** | **0.11** | **1** |

Notes: CR represents credit risk, CE stands for cost efficiency, LI is Lerner index, SIZE represents bank size, ROA stands for Return on Assets, SMD represents stock market development, GDPG is annual GDP growth rate.

**Table 6 Three-stage least square for the relationship between credit risk, cost efficiency and competition**

| | 3-stage least square for the relationship between credit risk, cost efficiency and competition | | |
|---|---|---|---|
| | Equation 1:<br>Credit risk as dependent variable | Equation 2:<br>Competition as dependent variable | Equation 3:<br>Cost efficiency as dependent variable |
| Credit risk | | -0.01***<br>(-14.92) | -0.05***<br>(-3.97) |
| Competition | -75.71***<br>(-17.43) | | -3.5***<br>(-5.41) |
| Cost efficiency | -16.78**<br>(-2.14) | -0.24***<br>(-3.07) | |
| Bank size | -1.37***<br>(-4.12) | -0.02***<br>(-3.98) | -0.07***<br>(-3.24) |
| ROA | | | -0.99<br>(-0.90) |
| Development of stock market | -0.002<br>(-0.06) | | |
| GDP growth rate | | -0.0005<br>(-0.93) | |
| Dummy 1 (joint-stock commercial banks) | -6.47***<br>(-7.13) | -0.09***<br>(-6.74) | -0.34***<br>(-0.82) |
| Dummy 2 (city commercial banks) | -8.02***<br>(-7.94) | -0.11***<br>(-7.38) | -0.42***<br>(-3.95) |
| Constant | 97.84***<br>(15.80) | 1.31***<br>(19.62) | 4.8***<br>(6.21) |
| Observations | 1100 | 1100 | 1100 |
| Chi square | 441.60*** | 345.61*** | 69.84 |

Notes: T-statistics in ( ).

*, **,*** represent statistical significance at 10%, 5% and 1%, respectively.