Does Financial Regulation Affect the Profit Efficiency and Risk of Banks? Evidence from China's Commercial Banks

Preliminary draft

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Abstract

The goal of financial regulation to enable banks to improve liquidity and solvency. Stricter regulation may be good for bank stability, but not for bank efficiency. This research aims to study the characteristics of China's financial regulation and explores how the regulation affects the profit efficiency, risk of China commercial banks. In addition, we also explore the trade-off relationship between efficiency and risk. Unlike other studies, the study uses bank asset as a classification standard from the financial risk and differential regulatory point of view.

The empirical results indicate that an increase in provision coverage ratio, on the other hand, can reduce the risk of large banks. A higher cost to income ratio implies a lower efficiency and more risk for large banks. On the contrary, these two ratios had no effect on the risk of small banks. Therefore, the CBRC regulates the provision coverage ratio and cost to income ratio seems meaningful for large banks. Small banks with higher capital adequacy ratio and leverage had a higher efficiency and a lower risk. For small banks, the loan to deposit ratio increases as risk increase. A higher loan to deposit ratio implies a lower efficiency. But, these three ratios did not a significantly affect large bank's risk. Similarly, the CBRC regulates the loan to deposit ratio, capital adequacy ratio and leverage ratio seems meaningful for small banks.

The purpose of CBRC regulates the current ratio is reduce the risk of bank. By our empirical results, the current ratio did not affect the risk and lead to different efficiency results between large and small banks. In an environment with asymmetric information, a bank decision-making is unobservable. The characteristics of financial regulation provide market clues if a bank is operating at the most efficiency and risk condition.

Keyword: Financial regulation, profit efficiency, Z-score, large and small banks
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1、Introduction

China had planned to introduce the bank capital standards, putting China under the global Basel III regime, at the start of 2012 year, a year ahead of the phase-in period stipulated in the Basel agreement. By moving the start date to January 1 2013, China confirmed that those original plans were too ambitious. The new timeline brings China in line with other countries. China had cited worries that the stricter rules would dampen domestic lending and hurt the economy at a time of global instability as reason for postponing the implementation from the original target date.

The China Banking Regulatory Commission (CBRC) released a set of guidelines for the banking industry, including imposing stricter requirements on capital bases, leverage, provision and liquidity, known widely as the China version of the new Basel III. The New Standards adopt capital adequacy rules and leverage ratios that are even more stringent than those of Basel III. In particular, the core tier 1 capital adequacy ratio will be set at 5 percent, 0.5 percent higher than Basel Ⅲ.The required leverage ratio will be set at 4 percent, 1 percent higher than required by the Basel III agreement. The challenges of implementing Basel II/III in China are clear: more stringent local requirements.

With a tougher definition and level of capital, there will be pressure for banks to understate their risk-weighted assets. In addition, the new capital requirements will greatly inhibit commercial banks' credit expansion and may swallow their profits, leading to a decline in return on assets and return on capital. Upon the implementation of the new rules, Chinese banks will have to consider possible ways of replenishing capital again. According to the 'official supervision approach', official supervision can reduce market failure by monitoring and discipline banks thus weakening corruption in bank lending and improving the functioning of banks as intermediaries (Beck et al., 2006). Alternatively, powerful supervisors may exert a negative influence on bank performance.

Capital serves as a buffer against losses that can absorb the possibility of bank failure (Dewatripont and Tirole, 1993). The leverage ratio has the role of helping to contain the compression of the risk based requirement. In the meantime, strengthened capital supervision will help to lower the probability of banking crisis. Barth, Caprio and Levine (2006) study what affects bank regulation and how banking regulation works. Their research on most countries shows that strong regulators and capital adequacy standards do not improve bank efficiency. Barth et al. (2004) put forward various reasons for and against restricting bank activities. However, overall their results indicate that restricting them may not only lower banking efficiency but also increase the probability of a banking crisis.

From the long-term point of view, as China economic growth is highly dependent on credit supply, the banks need to grow their loan scales at certain rates so as to support the sustained economic growth. Therefore, they will be faced with the needs for capital supplementation in order to keep up with the regulatory requirements on CAR. Pasiouras

(2008) mentioned that stricter capital adequacy, powerful supervision and market discipline power promote technical efficiency. However, only the latter one is significant. Too little capital increases the danger of bank failure whilst excessive capital imposes unnecessary costs on banks and their customers and may reduce the efficiency of the banking system. Furthermore, economic theory provides conflicting predictions about the impact of regulatory and supervisory policies on bank performance (e.g. Barth et al., 2004; 2007a).

Traditionally, commercial banks in China have reported a coverage ratio against non-performing loans in their financial results as an indicator. Chinese banks should be required to maintain such a provision coverage ratio at a 150% minimum. Furthermore, The CBRC issued a new 2.5 minimum loan-loss provision ratio for banks. It reflects how the regulator wants Chinese banks to set aside a precautionary amount of reserves ahead of the likelihood that an increasing proportion of their loans should turn bad. The new requirement represents the single biggest source of uncertainty for Chinese banks. This would result in bank non-performing loan levels rising, profitability falling and banks still needing more provisions. Banks will be also faced with the pressure of capital supplementation due to credit expansion.

Financial regulation will directly affect the behavior of commercial banks. Especially, as China commercial banks still follow the conventional business model, their ratios of deposits to total liabilities and of loans to total assets are relatively high. The main purpose of financial regulation is to enable banks to improve the liquidity and solvency. However, the implementation of bank regulation will enhance the efficiency or impede the efficiency? The goal of financial regulation is to enable banks to improve liquidity and solvency. The implementation of new regulatory standards will make the banking industry more robust, safeguard long-term stability of credit supply, thus supporting the sustained growth of economy. Stricter regulation may be good for bank stability, but not for bank efficiency. This also shows that policymakers and banks face the trade-off between financial stability and efficiency. Therefore, we need to assess the impact of the regulatory indicators in advance.

This research aims to study the characteristics of China's financial regulation and explores how the regulation affects the profit efficiency, risk of China commercial banks. In addition, we also explore the trade-off relationship between efficiency and risk. The study first use a profit model of the data envelopment analysis (DEA) and Z-score to investigate efficiency and risk from China commercial bank point of view. Our study covers a period of 8 years between 2004 and 2011. Then, we then use Tobit regression model to study the relationship between the financial regulation and the efficiency and use OLS regression model to study the relationship between the financial regulation and risk.

This study particularly described as follows. First, general literatures classified Chinese banks as state-owned banks, joint-stock banks, city and rural banks and foreign banks according to the bank established. This classification method may not play the function of

regulatory policies on risk prevention. Banks should be classified in accordance with the operating status. Furthermore, Chinese banks deemed to be systemically important banks (large bank) will be required to meet capital adequacy ratios of 11.5 percent, while other banks (small and medium banks) will be held to a 10.5 percent minimum.

This also means that the regulatory requirements for systemically and non-systemically important banks in the future will be the difference. Unlike other studies, the study uses bank asset as a classification standard from the financial risk and differential regulatory point of view. We adopt 1 trillion as standard and divide Chinese banks into two categories large and small banks.

Second, to investigate the relationship between financial regulation and the profit efficiency, risk of commercial banks, we adopt the following financial regulation variables. One is already implemented indicators in accordance with the provisions of the CBRC, but the indicators are not in Basel III provisions, for example loan loss provision, loan to deposit ratio etc. Another type is expected to be the implementation of indicators under the new Basel III regulations, but the BCBS adopted more stringent regulations than Basel III, for example leverage ratio and core tier 1 ratio.

Overall, our results indicate that an increase in provision coverage ratio, on the other hand, can reduce the risk of large banks. A higher cost to income ratio implies a lower efficiency and more risk for large banks. On the contrary, these two ratios had no effect on the risk of small banks. Therefore, the CBRC regulates the provision coverage ratio and cost to income ratio seems meaningful for large banks.Small bank with higher capital adequacy ratio and leverage had a higher efficiency and a lower risk. For small banks, the loan to deposit ratio increases as risk increase. A higher loan to deposit ratio implies a lower efficiency. On the contrary, these three ratios did not a significantly affect large bank’s risk. Therefore, the CBRC regulates the loan to deposit ratio seems meaningful for small banks.

The purpose of CBRC regulates the current ratio is reduce the risk of bank. By our empirical results, the current ratio did not affect the risk and lead to different efficiency results of large and small banks. In an environment with asymmetric information, a bank decision-making is unobservable. The characteristics of financial regulation provide market clues if a bank is operating at the most efficiency and risk condition.

The remainder of this paper is as follows. Section 2 introduce Basel III and the China banking regulation, Section 3 discusses the methodology, data used in the study and hypothesis, section 4 elaborates the empirical analysis, and section 5 summarizes our findings.

2. Basel III and the China Banking Regulation

2.1 China’s own version of Basel III

The CBRC issued a slew of new regulatory requirements for banks on various benchmarks they have to hit related to capital, liquidity and reserve requirements against loan losses, among others, as part of China’s planned implementation of the Basel III capital Accord. It is called China's Own Version of Basel III.

2.1.1 Higher Capital Requirements

The guidelines introduce a three-tier regulation standard in terms of the capital adequacy ratio of commercial banks. Three minimum capital adequacy ratios -- the "core capital adequacy ratio," the "tier-one capital adequacy ratio" and the "capital adequacy ratio"-- applicable to commercial banks of different sizes will be set at 5 percent, 6 percent and 8 percent, respectively. We are requiring much higher levels of capital to absorb the types of losses associated with crises. This includes an increase in the minimum common equity requirement from 2% to 4.5% and a capital conservation buffer of 2.5%, bringing the total common equity requirement to 7% under Basel III.

The new domestic regulatory standards and structural arrangements regarding capital adequacy ratio are largely consistent with Basel III, except for two differences. First, the domestic minimum requirement on core tier-1 (common stock) CAR is 5%, 0.5 percentages higher than that prescribed in Basel III. Second, the supplementary capital requirement for systematically important banks (SIBs) is temporarily set at 1%, while the Basel Committee and FSB have yet not reached consensus in this regard. In addition, a regulatory requirement for two capital buffers has also been introduced by the CBRC Guidelines: a 2.5 percent reserve excess capital conservation buffer and a 0-2.5 per cent countercyclical capital buffer. Last but not least, an additional capital requirement of 1 percent is imposed on systemically important banks.

2.1.2 Leverage Ratio

As a supplement to capital adequacy ratios, a leverage ratio is introduced. In order to facilitate banks to transform the development mode of relying on rapid expansion, strengthen self-discipline and improve the quality of development, it is necessary and viable to set the minimum leverage ratio at 4%. If the ratio is set too low, it will not effectively constrain the banks’ rapid expansion. The New Standards adopt a new leverage ratio of at least 4% of Tier 1 capital to total (including off-balance sheet) assets, 1 percentage point more than the Basel III requirement of at least 3%.

2.1.3 Stricter loan-loss provision rules

The loan-loss reserve requirement reflect how the regulator wants Chinese banks to set aside a precautionary amount of reserves ahead of the likelihood that an increasing proportion of their loans should turn bad. The rapid lending growth came after banks in China were told by their state shareholders to lend more to local governments to support Beijing’s fiscal

stimulus policy and spur the economy during the global financial crisis. This new requirement reflects the fact that, amid the high rate of loan growth in recent years, the CBRC is worried that even for loans that haven't turned bad just yet. Under the New Standards banks will be expected to have a loan provision ratio (i.e., a general loan provision ratio) of at least 2.5% and a provision coverage ratio (i.e., a ratio of provisions for specific nonperforming loans) of at least 150%.

2.1.4 Better Liquidity Rules

Generally speaking, as China banks still follow the conventional business model. CBRC aims to establish a multi-dimensionally liquidity risk control standards and will set out various ratios for supervisory purposes. These include a current ratio, a loan to deposit ratio, a core debt ratio, a liquidity gap ratio, deposit concentration, and an interbank funding ratio. In addition to the liquidity coverage ratio (LCR) and net stable finance ratio (NSFR) prescribed by Basel III, the New Standards contain rules intended to monitor liquidity risks. The CBRC Guidelines provide that the liquidity coverage ratio and the net stable finance ratio must not be lower than 100 percent.

2.2 CBRC's regulation of China's Banking Industry

We organized the above description into Table 1. By Table 1, we can clearly understand the current implementation and expected to be the implementation of regulation indicators. Therefore, the study will choose the financial regulation indicator according to the following table.

3. Methodology and Framework

The study first use a profit model of DEA and Z-score to investigate efficiency and risk from China commercial bank point of view. Then, we then use Tobit regression model to study the relationship between the financial regulation and the efficiency of bank and OLS method to study the relationship between the financial and the risk of bank.

3.1 Data Envelopment Analysis (DEA)

There are mainly two approaches in evaluating the efficiency of financial institutions. The first approach is the financial indicators analysis. This method does not reflect the value of management and conceal the long-term operational problem (Sherman and Gold, 1985). The second approach is economic efficiency analysis, which includes two methodologies; one is parametric and the other is nonparametric. For examples, stochastic frontier approach (SFA), thick frontier approach (TFA) and distribution-free approach (DFA) are parametric, and data envelopment analysis (DEA) and free disposal hull (FDH) are nonparametric.

Table 1 The CBRC’s regulation of China's Banking Industry

Regulation indicator	Definition	Required ratio	Estimated implementation time
1、Asset Quality			
Non-performing loan ratio	non-performing loans to loan outstandings	less than 5%	
Provision coverage ratio	loan-loss reserves to non-performing loans	shall be no lower than 150%	with a grace period of two years for the larger banks and five or seven years for small and medium-sized lenders,
Loan loss provision ratio	loan-loss reserves to loan outstandings	shall be no lower than 2.5%	systematically important financial institutions (sifis) in China will need to satisfy new Basel III requirements by the end of 2013; while non-sifis will have a longer transition period but still need to meet the rules by 2018.
2、Liquidity			
Loan to deposit ratio	loans to deposits	less than 75%	
Current ratio	current assets to current liabilities	shall be no lower than 25%	
Liquidity coverage ratio	stock of high quality liquid assets to net cash outflows over a 30-day time period	shall be no lower than 100%	meet the requirement as of end-2013
Net stable funding ratio	available amount of stable funding to required amount of stable funding	shall be no lower than 100%	meet the requirement as of end-2016
3、Benefit and Efficiency			
Cost to income ratio	operating costs to operating income	less than 45%	

4、Capital Adequate			
Capital adequacy Ratio(CAR)	net capital to risk weighted assets	shall be no lower than 8%	The capital adequacy ratio of SIFIs no lower than 11.5%（objective by the end of 2013）
Tier 1 (core) CAR	tier 1 capital to risk weighted assets	Basel III requirement of at least 6%	
Core Tier 1 CAR	common equity to risk weighted assets	no lower than 5%, 0.5% more than the Basel III requirement of at least 4.5%	
Leverage ratio	tier 1 capital to the adjusted on-and off-balance sheet assets of the relevant bank.	leverage rate no lower than 4%, 1% more than the Basel III requirement of at least 3%.	The regulator also required systemically important banks to meet the leverage ratio by the end of 2012, while other lenders must achieve the goal by the end of 2016.
Capital conservation buffer	drawing lessons from the crisis that banks were distributing earnings even during periods of stress	Basel III prescribes that a capital conservation buffer of 2.5%	
Countercyclical buffer capital	protect banking sector from periods of excess aggregate credit growth. Credit/GDP as the reference guide	countercyclical capital buffer 0-2.5%	
Additional capital of systematically important banks	the supplementary capital requirement for systematically important banks (SIBs)	set at 1% for the time being	

Source: CBRC website and constructed by the authors in accordance to related articles

Two most commonly adopted methods, SFA for parametric and DEA for nonparametric, have their own advantages and disadvantages. The SFA method can test hypotheses statistically and construct confidence intervals allowing for random errors. The effects of statistical noise or measurement errors can be distinguished from random errors. Researchers, however, may lose some flexibility in model specification. On the other hand, the DEA method cannot separate the statistical noise or the measurement errors from random errors. Researchers need not to assume the functional form relating inputs to outputs. Thus, the relative efficiency scores obtained from DEA may be subject to the effects from the uncontrollable factors.

DEA uses linear programming method to construct a piecewise linear surface or frontier over the investigated data. DEA searches for points with the lowest unit cost for any given output, and connecting those points to form the efficiency frontier. Any company not on the frontier is considered inefficient. A numerical coefficient is assigned to each firm, defining its relative efficiency (between 0 and 1) in comparison with efficient peers.

3.2 The Profit Efficiency Model

3.2.1 Model Description

Consider an industry producing *m* outputs from *n* inputs. An input–output bundle (*x*,*y*) is considered feasible when the output bundle y can be produced from the input bundle x. The technology faced by the firms in the industry can be described by the production possibility set

$$T = \{(x,y) : y \text{ can be produced from } x\} \quad (1)$$

In the single output case, one can conceptualize the production function

$$f(x) = \max y : (x,y) \in T \quad (2)$$

In the multiple output case, frontier of the production possibility set is the production correspondence $F(x,y) = 1$.

The method of Data Envelopment Analysis introduced by Charnes et al. (1978) and further extended to non-constant returns technologies by Banker et al. (1984) provides a way to construct the production possibility set from an observed data set of input–output bundles without assuming a functional form of the production technology**.**

Suppose that (x^j,y^j) is the input–output bundle observed for firm j ($j = 1,2,\ldots,N$). Clearly, these input–output bundles are all feasible. Then the smallest production possibility set satisfying the assumptions of convexity and free disposability that includes these observed bundles is

$$S = \langle (x,y) : x \geq \sum_{j=1}^{N} \lambda_j x^j ; y \leq \sum_{j=1}^{N} \lambda_j y^j ; \times \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0 (j = 1,2,\ldots, N) \quad (3)$$

The set *S* is also known as the free disposal convex hull of the observed input–output bundles. One can obtain various measures of efficiency of a firm using the set *S* as the reference technology. In the following paragraphs we describe how the efficiency of a firm can be measured under alternative assumptions on the choice variables.

For a commercial firm, both inputs and outputs are choice variables and the only constraint would be the feasibility of the input–output bundle chosen. For such a firm, the criterion of efficiency is profit maximization. At input and output prices *w* and *p*, respectively, the actual profit of the firm producing the output bundle y^0 from the input bundle x^0 is $\Pi^0 = p'y - w'x^0$. The maximum profit feasible for the firm is

$$\Pi(w, p) = \max \; p'y - w'x : (x, y) \in T$$

In any empirical application, the maximum profit may be obtained as

$$\Pi^* = \max \; p'y - w'x$$

$$\text{s.t.} \; \sum_{j=1}^{N} \lambda_j y^j \geq y; \sum_{j=1}^{N} \lambda_j x^j \leq x; \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0 (j = 1,2,..., N). \quad \text{.....(4)}$$

The profit efficiency of the firm is measured as $\delta = \frac{\Pi^0}{\Pi^{**}}$

This measure is also bounded between 0 and 1 except in the case where the actual profit is negative while the maximum profit is positive. In that case δ is less than 0. If the maximum profit is negative as well, δ exceeds unity.

3.2.2 Data and Definitions

General literatures classified Chinese banks as state-owned banks, joint-stock banks, city and rural banks and foreign banks according to the bank established. This classification method may not play the function of regulatory policies on risk prevention. Banks should be classified in accordance with the operating status. Furthermore, Chinese banks deemed to be systemically important banks (large bank) will be required to meet capital adequacy ratios of 11.5 percent, while other banks (small and medium banks) will be held to a 10.5 percent minimum. This also means that the regulatory requirements for systemically and non-systemically important banks in the future will be the difference.

Unlike other studies, the study uses bank asset as a classification standard from the financial risk and differential regulatory point of view. We adopt 1 trillion[1] as standard and divide Chinese banks into two categories large and small banks. Our research data are from the Bankscope, the CBRC and the financial statements published by commercial banks. They are unbalanced data[2]. The study covers a period of 8 years between 2004 and 2011. In late

[1] As the former China Banking Regulatory Commission chairman Liu said, the bank's assets more than 1 trillion will be treated as a large bank.

[2] The number of large banks and small banks are listed in Appendix Table A1. The proportion of large and small

2006, the State Council, China's cabinet, released a regulation giving foreign banks a five-year grace period from 2007 to comply with the 75% limit[3]. The regulation between China domestic banks and foreign banks is different. Therefore, foreign banks were excluded from the original sample.

There are many ways to define and categorize input and output variables in banking literatures, and in this study we adopt the intermediation approach[4] (Lin, 2002; Shen and Chen, 2008) to define the input and output of financial institutions. Table 2 lists the definitions of these variables.

Table 2 Definitions of Input and output variables

Variable	Variable Name	Description
Input	Fixed assets	The sum of physical capital and premises
	Funds	Total deposits plus total borrowed funds
Input price	Price of fixed assets	Operating expenses divided by the fixed assets
	Price of funds	Interest expenses on customer deposits plus other interest expenses divided by the total funds
Output	Total loans	Total of short-term and long-term loans
	Investment	Includes short and long term investment
Output price	Price of loans	Interest income on loans divided by total loans
	Price of investment	Other operating income divided by investments

3.3 Definition of Z-Score

The assessment of banking risk is traditionally executed by analyzing various key financial ratios (e.g. the ratio of nonperforming loans to total loans, the ratio of provisions for nonperforming loans to total assets, etc...). These variables have been criticized by the empirical literature because the ratio method is not based on any theoretical basis, and even in its most elaborated form, the ratios method does not take into account the impact of diversification on risk.

bank assets is listed in Appendix Table A2.

[3] On 11 December 2006, the Regulation on the Administration of Foreign-funded Banks (issued by the State Council) and related implementing rules (issued by the CBRC) came into force. A five-year grace period for foreign banks to comply with China's 75% loan-deposit ceiling will expire on Dec. 31, 2011.

[4] The intermediation approach views bank as an intermediator of financial services and assumes that banks collect funds (deposits and purchased funds with the assistance of labor and capital) and transform these into loans and other assets.

Therefore, we will use the Z-score measure to assess the bank risk and to overcome the shortcomings of the ratios method. This comprehensive measure takes into account both risks related to banking business and the degree of coverage of these risks by the capital (Goyeau and Tarazi, 1992). The Z-score indicator can be estimated using the probability of default extracted from Roy (1952) and developed by Goyeau and Tarazi (1992). The probability of default is the probability that losses exceed the equity, or when the net worth becomes negative (Roy, 1952; Boyd and Graham, 1988). This may be written as:

Probability of default = Prob ($\pi < -E$)

It is possible to calculate different indicators of banking risks depending whether we divide the two terms of the inequality by the equity or by the total assets.

In this study, dividing by the value of assets results in an indicator in terms of return on assets. It provides an indicator Z , which allows separating explicitly the risk effect from the risk coverage of the bank capital. The probability of default can be written as:

$$\Pr ob(\frac{\overline{\pi}}{A} \le -\frac{E}{A}) = \Pr ob(\overline{ROA} < -\frac{E}{A}) \quad \text{.....(5)}$$

where $\overline{ROA}$ is the return on assets and A is the total assets of the bank. Equation (5) is rewritten as:

$$\Pr ob\langle \frac{(\overline{ROA} - \mu_{ROA})}{\sigma_{ROA}} \le \frac{(-\lambda - \mu_{ROA})}{\sigma_{ROA}} \rangle = \Pr ob\langle \frac{(\overline{ROA} - \mu_{ROA})}{\sigma_{ROA}} < -Z \rangle \quad \text{.....(6)}$$

where μ_{ROA} and σ_{ROA} are the mean and standard deviation of *ROA* and and $Z = \frac{(\frac{E}{A} + \mu_{ROA})}{\sigma_{ROA}}$ is the indicator of fragility.

The indicator Z can be considered as an indicator of bank fragility. A higher value of Z corresponds to a lower default risk.

3.4 Tobit and OLS Regression Model

3.4.1 Model and Variable

To investigate the relationship between financial regulation and the profit efficiency, risk of commercial banks, we adopt the following financial regulation variables.One is already implemented indicators in accordance with the provisions of the CBRC, but the indicators are not in Basel III provisions, for example loan loss provision, loan to deposit ratio[5] etc. Another type is expected to be the implementation of indicators under the new Basel III regulations, but the BCBS adopted more stringent regulations than Basel III, for example leverage ratio

[5] While catching up with international standards, CBRC also retain some requirements widely used among Chinese commercial banks, such as a loan-to-deposit ratio of no more than 75 percent.

and core tier 1 ratio.

According to the CBRC, we divided the financial regulation variable into four categories, asset quality, benefit and efficiency, liquidity and capital adequacy. In all respects, we therefore select the provision coverage, loan-loss provision ratio, cost to income ratio, loan to deposit ratio, current ratio, capital adequacy ratio, and leverage ratio as the explanatory variables. We finally use the establishment time as control variables to level their effects on financial regulation. Table 3 lists the definitions for these variables. The descriptive statistics for regulation variables are represented shown in Appendix Table A2.

We apply Tobit regression model to study the relationship between financial regulation and the profit efficiency of bank. The study selects the profit efficiency is estimated by profit model as the explained variable. The efficiency scores (as the explained variable) from DEA are limited to value between 0 and 1. Because the explained variable in the regression equation cannot be expected to have a normal distribution. Thus, we cannot expect the regression error also meet the assumption of normal distribution. The OLS method as a result often leads to biased and inconsistent parameter estimates (Greene, 1981). We therefore use Tobit estimation (Coelli, Prasada Rao and Battese,1998; Fried, Schmidt and Yaisawarng,1999; Wang et al., 2003; Lin,2002) in this study.

Model 1：

$Y_t = bX_t + \varepsilon_t$ ， $\varepsilon_t \sim N(0,\sigma_t^2)$

$Y(\text{profit efficiency}) = a_o + b_1 \times RES\_NPL + b_2 \times CIR + b_3 \times LIQ + b_4 \times CAR + b_5 \times Time + \varepsilon_t$ ……(7)

Model 2：

$Y_t = bX_t + \varepsilon_t$ ， $\varepsilon_t \sim N(0,\sigma_t^2)$

$Y(\text{profit efficiency}) = a_o + b_1 \times RES\_Loan + b_2 \times CIR + b_3 \times LDR + b_4 \times Leverage + b_5 \times Time + \varepsilon_t$ ……(8)

We apply OLS regression model to study the relationship between financial regulation and risk of a bank. The study selects the Z-score as the explained variable.

Model 3：

$Y_t = bX_t + \varepsilon_t$ ， $\varepsilon_t \sim N(0,\sigma_t^2)$

$Y(\text{Z-score}) = a_o + b_1 \times RES\_NPL + b_2 \times CIR + b_3 \times LIQ + b_4 \times CAR + b_5 \times Time + \varepsilon_t$ ……(9)

Model 4：

$Y_t = bX_t + \varepsilon_t$ ， $\varepsilon_t \sim N(0,\sigma_t^2)$

$Y(\text{Z-score}) = a_o + b_1 \times RES\_Loan + b_2 \times CIR + b_3 \times LDR + b_4 \times Leverage + b_5 \times Time + \varepsilon_t$ ….(10)

Table 3 Definition of explanatory variables

Variable code	Variable name	Description
1、Asset Quality		
RES_NPL	provision coverage ratio	non-performing loans to loan outstandings
RES_Loan	loan loss provision ratio	loan-loss reserves to loan outstandings
2、Benefit and Efficiency		
CIR	cost to income ratio	operating costs to operating income
3、Liquidity		
LIQ	current ratio	current assets to current liabilities
LDR	loan to deposit ratio	loans to deposits
4、Capital Adequate		
CAR	capital adequacy ratio	net capital to risk weighted assets
Leverage	leverage ratio	Basel III definition： core capital to the adjusted on-and off-balance sheet assets of the relevant bank Our study definition： tier 1 capital to total asset It is difference in the definition of denominator. The ratio in our study is only for estimation and may be deviation from the actual level.
5、Control Variables		
Time	the establishment time	It is the cumulative year of the establishment time

3.4.2 Hypothesis

According to our model, we construct seven hypotheses for the relationship between financial regulation and profit efficiency, risk, as shown in Table 4.

Table 4 Hypothesis

	Hypothesis	Description	Related literature
Aasset Quality	H1	The provision coverage ratio has no effect on the profit efficiency (or risk) of a bank.	Ayadi & Pujals, 2005
	H2	The loan-loss provision ratio has no effect on the profit efficiency (or risk) of a bank.	
Benefit and Efficiency	H3	The cost to income ratio has no effect on the profit efficiency (or risk) of a bank.	Xiong and Sun (2009)、Francis (2004) and Ghosh et al. (2003)
Liquidity	H4	The current ratio has no effect on the profit efficiency (or risk) of a bank.	Athanasoglou, Delis & Staikouras (2006)、Ayadi and Pujals(2005)

	H5	The loan to deposit has no effect on the profit efficiency (or risk) of a bank.	
Capital Adequacy	H6	The capital adequacy has no effect on the profit efficiency (or risk) of a bank.	Zhong (2007)
	H7	The Leverage ratio has no effect on the profit efficiency (or risk) of a bank.	

Assets Quality：'Loan Loss Reserve' for loan impairment is the amount that reduces the recorded investment in a loan portfolio to the carrying amount on the balance sheet. The ratio estimates the portion of total loans that may prove to be bad loans and acts insurance reserves for potential problem loans. It provides an indication of the extent to which the bank has made provisions to cover credit losses, and in turn to impair net interest revenue on the income statement. The higher the ratio, the larger is the amount of expected bad loans on the books, and the higher are the risks despite having been provisioned (Ayadi and Pujals, 2005). On the other hand, a higher ratio also indicates the improvement in asset quality management.

Benefit and Efficiency：The cost income ratio, defined by operating expenses divided by operating income, can be used for benchmarking by the bank when reviewing its operational efficiency. Lower is better. Francis (2004) observes that there is an inverse relationship between the cost income ratio and the bank's profitability. Ghosh et al. (2003) also find that the expected negative relation between efficiency and the cost-income ratio seems to exist. Xiong and Sun (2009) pointed that the cost to income ratio had a significant negative effect on efficiency of bank.

Liquidity：A liquidity problem usually arises from the possible inability of a bank to accommodate decreases in liabilities or to fund increases on the assets' side of the balance sheet (Athanasoglou, Delis and Staikouras 2006) The higher this ratio is, the stronger is a position of a bank to absorb liquidity shocks (Ayadi and Pujals, 2005). However, since liquid assets tend to be low yielding, a higher ratio implies lower earnings. As a measure of liquidity, the ratio may reflect how well the funding sources match the funding uses.

Capital Adequacy：Capital Adequacy is a measure of a bank's financial strength, in terms of its ability to withstand operational and abnormal losses. Adequate bank capital can function to reduce bank risk by acting as a buffer against loan losses, providing ready access to financial markets in turn to guards against liquidity problem and limiting risk taking but also constraining growth (Zhong, 2007). Most banks regulators see capital adequacy regulation as a means of strengthening the safety and soundness of the banking industry. In China, with the establishment of the CBRC in 2003, the 8% minimum capital adequacy ratio. As a supplement to capital adequacy ratios, a leverage ratio is introduced. If the ratio is set too low, it will not effectively constrain the banks' rapid expansion

4、Empirical Analysis

4.1 The correlation analysis

We further study whether the characteristic of financial regulation affects the efficiency and risk of bank. We then use Tobit (OLS) regression model to study the relationship between the financial regulation and the profit efficiency (risk) of large and small bank. We apply the correlation analysis on explanatory and explained variables to examine multicollinearity. The correlation coefficient of the capital adequacy ratio was highly related with leverage ratio (0.805). Appendix Table A3 lists the coefficient of correlation.

4.2 The Relationship between the Financial Regulation and Efficiency and Risk

The explained variables in Tobit regression model are obtained from the profit efficiency in profit model; the explained variables in OLS regression model are obtained from the Z-score.Then, we estimate the relationship between financial regulation and the profit efficiency and risk of bank between 2004 and 2011. As shown in Table 5. Table 6 lists the significant empirical results.

Asset Qualtiy

Table 6 showed that the loan loss provision ratio had a significant positive effect on efficiency of large banks. The higher the ratio, the more efficiency for a bank. The coefficient for provision coverage ratio is significantly positive, which implies that the higher the ratio, the less risk for a bank. This shows that large banks had greatly enhanced ability to resist risks. But, these two ratios did not a significantly affect small bank's efficiency and risk.

Benefit and efficiency

The cost to income ratio had a significant negative effect on efficiency of large and small banks. The higher the cost to income ratio, the less efficiency for a bank. For large banks, the coefficient of cost to income ratio is significantly negative. The higher the cost to income ratio, the more risk for a bank. But, the ratio did not a significantly affect small bank's risk. This shows that large banks should pay attention to the cost of control than small banks.

Liquidity

The current ratio had a significant negative effect on efficiency of large banks, the higher ratio of liquidity may lead to significantly impede the efficient operation of banks due to fund idle. But, the current ratio had a significant positive effect on efficiency of small banks. The purpose of CBRC regulates the current ratio is reduce the risk of bank. By our empirical results, the current ratio did not affect the risk and lead to different efficiency results of large and small banks

Table 5 The relationship between financial regulation and profit efficiency and risk for large and small banks

Explained variable	Efficiency				Risk			
Model	Model 1		Model 2		Model 3		Model 4	
Bank type	Large banks	Small banks	Large banks	Small banks	Large banks	Small banks	Large banks	Small banks
Coeff.(SD) / Explanatory variable	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)
RES_NPL	-0.0002	0.00001			**0.0031***	0.0010		
	(0.0002)	(0.0001)			(0.0018)	(0.0007)		
RES_Loan			**0.0955****	0.0174			0.1883	0.0457
			(0.0389)	(0.0177)			(0.3034)	(0.0952)
CIR	**-0.0148*****	**-0.0145*****	**-0.0076****	**-0.0142*****	**-0.0877*****	0.0053	**-0.1145*****	0.0051
	(0.0039)	(0.0020)	(0.0036)	(0.0019)	(0.0291)	(0.0106)	(0.0253)	(0.0105)
LIQ	**-0.0113*****	**0.0033***			0.0190	0.0026		
	(0.0027)	(0.0018)			(0.0207)	(0.0093)		
LDR			0.0008	**-0.0046*****			0.0444	**-0.0226****
			(0.0051)	(0.0017)			(0.0437)	(0.0089)
CAR	-0.0095	0.0057			-0.0081	**0.0451***		
	(0.0143)	(0.0045)			(0.1203)	(0.0258)		
Leverage			0.0113	**0.0168****			-0.0404	**0.0923****
			(0.0213)	(0.0070)			(0.1570)	(0.0390)
Time	**-0.0018*****	-0.0020	**-0.0012****	-0.0005	**0.0078****	-0.0043	0.0022	0.0090
	(0.0005)	(0.0036)	(0.0005)	(0.0035)	(0.0037)	(0.0199)	(0.0036)	(0.0191)
R-squared					0.4490	0.0546	0.3373	0.0560
Adjusted R-squared					0.3878	0.0243	0.2637	0.0257

Note：***, **, * represent significance at the 1%, 5%, and 10% levels, respectively.

Loan to deposit ratio only affect the efficiency and risk of small banks. The higher the ratio, the less efficiency and more risk for a bank. Therefore, the CBRC regulates the ratio seems reasonable and meaningful for small banks. The loan to deposit ratio did not a significantly affect large bank's efficiency and risk. The loan to deposit ratio of large banks is lower than small banks, the sources of funding is more stable.

Capital Adequacy

The capital adequacy ratio and leverage ratio did not a significantly affect large bank's efficiency and risk. For small bank, the capital adequacy did not a significantly affect on efficiency, but it can reduce the risk. The leverage ratio had a significant positive effect on efficiency of small bank. The higher the ratio, the lower risk for a bank. The capital requirement can reduce the risk of small banks.

Control Variable

The establishment time had a significant negative effect on efficiency of large banks. The longer the establishment time, the lower efficiency and risk for a bank.

Table 6 Significant results under the Tobit and OLS regression model：distinguish between efficiency and risk

	Efficiency		Risk	
	Model 1	Model 2	Model 1	Model 2
Large bank	CIR (-) LIQ (-) Time (-)	RES_Loan (+) CIR (-) Time (-)	RES_NPL (+) CIR (-) Time (+)	CIR (-)
Small bank	CIR (-) LIQ (+)	CIR (-) LDR (-) Leverage (+)	CAR (+)	LDR (-) Leverage (+)

Table 7 distinguishes between large and small banks and lists the significant empirical results. The loan loss provision ratio and liquidity ratio did not a significantly affect large and small bank's efficiency and risk. An increase in provision coverage ratio, on the other hand, can reduce the risk of large banks. The coefficient for cost to income ratio is significantly negative, which implies that the higher the ratio, the less efficiency and more risk for large banks. Therefore, the CBRC regulates the provision coverage ratio and cost to income ratio seems meaningful for large banks. On the contrary, these two ratios had no effect on the risk of small banks. For small banks, the loan to deposit ratio is significantly negative which implies that the ratio increases as risk increase. A higher loan to deposit ratio implies a lower efficiency. Small bank with higher capital adequacy ratio and leverage had a higher efficiency and a lower risk. On the contrary, these three ratios did not a significantly affect large bank's

risk.

We think the adoption of the New Standards is likely to put pressure on Chinese banks. It is imperative for commercial banks to change the profit model. Faced with greater challenges in terms of capital adequacy ratios and liquidity, China's commercial banks are vigorously developing capital-saving products and growing non-interest-related income to contribute more than half of their total incomes. Therefore, the banking sector should make more efforts on credit structure adjustment and credit quality improvement in the coming period of time, which is also the expected goal of the CBRC in its efforts to boost the implementation of new regulatory standards.

Table 7 Significant results under the Tobit and OLS regression model：distinguish between large and small banks

	Large bank		Small bank	
Regulation variable	Efficiency	Risk	Efficiency	Risk
RES_NPL	no effect	(+)	no effect	no effect
RES_Loan	(+)	no effect	no effect	no effect
CIR	(-)	(-)	(-)	no effect
LIQ	**(-)**	no effect	**(+)**	no effect
LDR	no effect	no effect	(-)	(-)
CAR	no effect	no effect	no effect	(+)
Leverage	no effect	no effect	(+)	(+)
Time	(-)	(+)	no effect	no effect

Table 8 Summary of Hypotheses Results

			Efficiency				Risk			
			Large bank		Small bank		Large bank		Small bank	
Regulation index	Hypothesis	Descriptions	Model 1	Model 2	Model 1	Model 2	Model 3	Model 4	Model 3	Model 4
Asset Quality	H1	The provision coverage ratio has no effect on the profit efficiency (or risk) of a bank.	consistent	consistent	consistent	consistent	**inconsistent**	consistent	consistent	consistent
	H2	The loan-loss provision ratio has no effect on the profit efficiency (or risk) of a bank.	consistent	**inconsistent**	consistent	consistent	consistent	consistent	consistent	consistent
Benefit and Efficiency	H3	The cost to income ratio has no effect on the profit efficiency (or risk) of a bank.	**inconsistent**	**inconsistent**	**inconsistent**	**inconsistent**	**inconsistent**	**inconsistent**	consistent	consistent
Liquidity	H4	The current ratio has no effect on the profit efficiency (or risk) of a bank.	**inconsistent**	consistent	**inconsistent**	consistent	consistent	consistent	consistent	consistent
	H5	The loan to deposit has no effect on the profit efficiency (or risk) of a bank.	consistent	consistent	consistent	**inconsistent**	consistent	consistent	consistent	**inconsistent**
Capital Adequacy	H6	The capital adequacy ratio has no effect on the profit efficiency (or risk) of a bank.	consistent	consistent	consistent	consistent	consistent	consistent	**inconsistent**	consistent
	H7	The Leverage ratio has no effect on the profit efficiency (or risk) of a bank.	consistent	consistent	consistent	**inconsistent**	consistent	consistent	consistent	**inconsistent**

5、Conclusion

The CBRC released a set of guidelines for the banking industry, including imposing stricter requirements on capital bases, leverage, provision and liquidity. This research aims to study the characteristics of China's financial regulation and explores how the regulation affects the profit efficiency, risk of China commercial banks. The purpose of CBRC regulates the current ratio is reduce the risk of bank. By our empirical results, the current ratio did not affect the risk and lead to different efficiency results of large and small banks.

The empirical results indicate that an increase in provision coverage ratio, on the other hand, can reduce the risk of large banks. A higher cost to income ratio implies a lower efficiency and more risk for large banks. On the contrary, these two ratios had no effect on the risk of small banks. Therefore, the CBRC regulates the provision coverage ratio and cost to income ratio seems meaningful for large banks. Small banks with higher capital adequacy ratio and leverage had a higher efficiency and a lower risk. For small banks, the loan to deposit ratio increases as risk increase. A higher loan to deposit ratio implies a lower efficiency. On the contrary, these three ratios did not a significantly affect large bank’s risk. Similarly, the CBRC regulates the loan to deposit ratio, capital adequacy ratio and leverage ratio seems meaningful for small banks.

In an environment with asymmetric information, a bank decision-making is unobservable. The characteristics of financial regulation provide market clues if a bank is operating at the most efficiency condition. This also explains that the policymaker and banks face a trade-off between financial risk and efficiency. Stricter regulation may be good for bank stability (reduce risk), but not for bank efficiency. In order to fit the new requirements, it is imperative for commercial banks to change the profit model. Therefore, the banking sector should make more efforts on credit structure adjustment and credit quality improvement in the coming period of time, which is also the expected goal of the CBRC in its efforts to boost the implementation of new regulatory standards.

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Appendix Table

As shown in Table A1 and A2. A small number of large banks, but the high proportion of assets. A larger number of small banks, but the low proportion of assets. The proportions of large banks' assets are increasing after 2006. Similarly, the proportions of small banks' assets are decreasing after 2006.

Table A1 The number of large and small banks

Number of bank	2004	2005	2006	2007	2008	2009	2010	2011	
Large	3	4	4	6	9	9	11	11	57
Small	9	21	36	36	21	22	24	16	185
Total	12	25	40	42	30	31	35	27	242

Table A2 The proportion of large and small bank assets

Asset ratio	2004	2005	2006	2007	2008	2009	2010	2011
Large	88.46	85.80	84.47	88.87	90.46	91.32	91.10	92.68
Small	11.54	14.20	15.53	11.13	9.54	8.68	8.90	7.32
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

By the following table shows that the large banks had better profit efficiency and low risk compared to small banks. In addition to loan loss provision ratio, the remaining regulation variables all meet the requirement of CBRC. The average loan loss provision ratio stands at 2.40% and 2.07% (lower than 2.5%) for large and small banks.

Table A2 Summary statistics for regulation variables

Variable	Statistics / Bank type	Average	Min	Max	SD	Regulated ratio
PE	Large banks	0.8161	0.5304	1.0000	0.1535	
	Small banks	0.6582	0.0966	1.0000	0.2702	
ln(Z-score)	Large banks	3.8501	1.7446	5.4534	0.7505	
	Small banks	3.7448	1.3207	7.1241	1.0467	
RES_NPL	Large banks	182.5477	45.5300	499.6000	99.8267	shall be no lower than 150%
	Small banks	166.4506	1.8600	828.8700	142.0697	
RES_Loan	Large banks	2.3982	1.3200	4.0800	0.6270	shall be no lower than 2.5%
	Small banks	2.0727	0.1800	5.9700	1.0001	
CIR	Large banks	37.6008	29.1730	56.0750	5.4230	less than 45%
	Small banks	39.5489	22.4070	74.2710	8.9911	
LIQ	Large banks	26.5300	11.7120	43.9640	7.7259	shall be no lower than 25%
	Small banks	24.9706	3.8830	71.2710	10.3760	
LDR	Large banks	56.3300	46.4120	66.4620	4.9160	less than 75%
	Small banks	57.3850	22.0360	106.0000	10.7803	
CAR	Large banks	11.8284	9.0700	15.2700	1.4041	shall be no lower than 8%
	Small banks	10.9940	-1.4700	30.1400	4.2118	
Leverage	Large banks	5.2972	2.8902	8.0988	0.9419	leverage rate no lower than 4%, 1% more than the Basel III requirement of at least 3%.
	Small banks	5.4153	-0.8369	23.8166	2.6188	
Time	Large banks	47.2807	12.0000	103.0000	33.7378	
	Small banks	10.7784	1.0000	23.0000	4.8274	

Table A3 The correlation coefficient

	PE	ln (Z-score)	RES_NPL	RES__Loan	CIR	LDR	LIQ	CAR	Leverage	Time
PE	1									
ln (Z-score)	.096	1								
RES_NPL	.119	.036	1							
RES__Loan	.162(*)	-.014	-.066	1						
CIR	-.496(**)	-.021	-.153(*)	-.086	1					
LDR	-.169(**)	.063	-.049	-.304(**)	.036	1				
LIQ	.114	-.086	.450(**)	.089	-.065	-.338(**)	1			
CAR	.264(**)	.104	.354(**)	-.037	-.300(**)	.020	.218(**)	1		
Leverage	.150(*)	.148(*)	.203(**)	-.248(**)	-.174(**)	.327(**)	.065	.805(**)	1	
Time	.142(*)	-.078	-.029	.149(*)	-.076	-.042	-.024	.104	-.002	1

Note：***, **, * represent significance at the 1%, 5%, and 10% levels, respectively. ※ represents significance with bootstrapping method.