Hypothetical Potential Merger in South Eastern Chinese Commercial Banks: An Analysis of Cost Efficiency

A Dissertation Presented By

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to

The Nottingham University Business School

Msc Banking and Finance

2014

Abstract

The objective of this paper is to use the estimation of x-efficiencies and scale efficiencies by the cost function of commercial banks operating in China to identify expected cost savings of the hypothetical potential mergers. The x-efficiencies of the banking industry increase dramatically since 2009 and their scale efficiencies show the inverted U-shaped curve that small banks have economies of scale while large banks have diseconomies of scale. The average scale inefficiencies are 14.38% and the x-efficiencies are 7.26%. The merger cost reduction is mainly affected by scale inefficiencies. The changing in input ratio also has an effect on the results in cost savings but the positive effect or negative effect may also influence by other reasons such as regulations or government policy.

Acknowledgement

I would like to sincerely thank my supervisor Dr. Richard Simper for his patience, guidance and understanding. What he taught me at the University of Nottingham Business School has encouraged my work in this field. His mentorship was important to provide me a sound experience consistent my long-term career goals. He presents me to not only becoming a student well understanding the theories of the textbooks, but also as an analyst and independent thinker. I am not certain that every graduate can have the opportunity he provides to help me develop my own skills of quantitative analysis and ability of fulfilling work independently. For everything you've done to me, Dr. Simper, I should say thank you very much.

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1. Introduction

Since 1990s, mergers have become an increasing important component in the Chinese banking system development and modification. It started as a government macro-economic management method to stimulate bank reform and address the bankruptcy, banking institutions to enhance Chinese economic development. After China enters WTO in 2001, Chinese banking regulations have become more international with the creation of the China Banking Regulatory Commission (CRBC) in 2003 and acceptance of Basel II and III after 2009. Additionally, its opening-up encourages foreign ownership to participate and merged in the Chinese banking sector. In China, the commercial banks include Stated-owned Commercial Banks, Joint-equity Commercial Banks and City Commercial Banks. In the domestic banking markets, joint-equity commercial banks and city commercial banks has increasing important roles in this area and they are also the focus of this article. Bank mergers' efficiencies analysis of China studies the relationship between scale economies and cost efficiencies of banks (see, for example, Berger & Humprhey, 1992). However, literature on Chinese banking mergers are less focused on studying the relationship between x-efficiencies and merger cost efficiencies. Hence, one objective of my paper is to fill this deficiency.

This paper provides the methodology following Altunbas et al. (1997) and Hadad et al. (2013) to study the hypothetical potential mergers to be used as the guide for the process of consolidation in the Chinese commercial banking industry. This methodology requires Stochastic Frontier Analysis (SFA) to estimate the bank cost function using the selected banks' data following restricted criteria, which then can

be used to estimate banks' scale efficiencies. In addition, as the historical function, the merger was the management tool to address the Chinese banking bankruptcy which can also be estimated by z-scores in this paper, higher z-score indicates a lower risk of failure. Notably, this paper studies the hypothetical mergers rather than actual ones. The objective of this paper will include being the guide for Chinese commercial banks further mergers in the future.

This paper aims to estimate and discuss the effect of scale efficiencies and x-efficiencies on the hypothetical mergers' cost improvements. Additionally, this paper also analyses the effects of changing in inputs percentages on differences of hypothetical mergers' cost improvements. Moreover, the Chinese commercial banks' hypothetical potential merger analysis should use frontier techniques instead of standard financial ratio analysis (Bauer, Berger, Ferrier, and Humphrey, 1998).

This paper follows the structure as: next section reviews the history of the Chinese banking system, the related regulations, the categories of Chinese Commercial Banks, Bank efficiency in China and the merger conditions in China. Section 3 provides the estimation methodology and the sample selection processes and Section 4 presents the data and variables used in the quantitative analysis. Section 5 discusses the estimation results of sample banks' x-efficiencies and scale efficiencies and analyses the Chinese hypothetical merger commercial bank's cost efficiencies. In addition, this section also discusses the amount of four individual hypothetical merger bank' cost savings under three models with different level of inputs through sample period. And the last section summaries and concludes with suggestions for future study.

2. Literature Review

2.1 History of Chinese banking system

The Chinese banking industry is continuously changing due to the political and economic environment shifts. The shifts can be categorised into 2 stages: pre-2001, the stage of the Chinese banking system to transfer from state-owned banks to commercial banks; post-2001, after China entered WTO, the international business increases and more modern banking regulation were launched.

Before China Enter WTO

The Chinese banking system started from the late 1940s with the central bank, the People's Bank of China (PBOC), first established. The People's Bank of China operated as a central bank and a commercial bank during the period of Cultural Revolution in 1966 to 1976, and then PBOC was responsible for monetary and fiscal control and currency issue. Before the reform in 1978, Chinese Banking system was monopoly owned by PBOC and Ministry of Finance, hence, the banking system at that period is not for earning more profit but fulfil the national production plans. After 1978, Chinese banking system expanded with the policy support, four state-owned banks established to operating lending business. These four banks are called "Big Four" including: The Bank of China (BOC), China Construction Bank (CCB), Agricultural Bank of China (ABC), and Industrial and Commercial Bank of China (ICBC). These banks were not operating as competitors with different functions: The BOC responsible for foreign trade and exchange; CCB responsible for construction; ABC and ICBC, responsible for agricultural and industrial and commercial lending correspondingly. This function division situation in Chinese banking system caused low incentives to compete and poor efficiency of banking operation.

The problems caused by limited competition of Big Four gradually were solved in the mid-1990s due to more and more state-owned banks reformed into commercial banks. The Big Four lend the loans mainly to state-owned companies and organisations that have low interest and incentive to pay back the loans in time. Hence, the bad debt percentage was too high to threat the entire banking system. In 1994, the state policy book established to take over the business of policy-lending of the Big Four. In 1998, Ministry of Finance issued special bonds (RMB 270 billion in 30-year government bonds) to recapitalize the Big Four banks. Asset Management Companies (AMC) were founded in the same year to buy the non-performing loans (20% of total loans) in Big Four banks.

However, According to Chen *et al.* (2005), the so-called functional division was not entirely successful. The policy banks were lack of branch to build network and had insufficient capital adequacy. Under the pressure of central and local government demand, commercial banks continued to operate their policy lending businesses, which also provides the development opportunities of joint-equity commercial banks. At the end of 1990s, large joint-stock commercial banks were able to compete with the Big Four state-owned banks. For instance, the China Merchants Bank replaced the Agricultural Bank of China to be the fourth largest profit maker in China.

After Entering WTO in 2001:

Following the rules of WTO, Chinese banking system regulations have also been changed. For example, the Commercial Bank Law and Central Bank Law issued in 1995 were revised. Entering WTO, China can have more fair treatment of tax rates

on exporting, more liberalization of interest rate, lower legal restriction on ownership takeovers or Mergers and Acquisitions, and more freedom of trans-regional operation in Chinese Banking industry.

China Banking Regulatory Commission (CBRC) was the institution created and authorised by the government in 2003 to monitor the operations of the Chinese banking system and issue regulations and rules. CBRC used new regulations to address banks' bad debt problems, example of allocating US $45 billion to Bank of China (BOC) and China Construction Bank (CCB) to help them raise capital for the provision for doubtful debt in 2003. Moreover, the number of domestic banks owned by the foreign banks or companies increases year by year since the beginning of the 21st century. However, Chinese policy restricts clearly on the percentage of foreign ownership in banks. Following Barnes (2008), banking regulations restrict foreign ownership to a maximum of 25% per bank (20% to a single foreign owner) and shareholdings in a maximum of two Chinese banks. In December 2003, Hang Seng Ltd, IFC and etc. bought 24.98% of Industrial Bank to become the shareholders of this southern Fujian Province-based bank held by the Fujian Provincial Bureau of Finance at 34%, a unit of HSBC Holding Plc, Hong Kong and Shanghai Banking Corp., using US $ 1.75 billion to acquire 19.9% stake in Bank of Communication which is the fifth largest commercial banks in China and 23.76% holding by Ministry of Finance in China.[1]

[1]According to Berger et al. (2009) nine city commercial banks have agreed to sell partial stakes to foreign investors, these banks includes: Bank of Beijing, Bank of Shanghai, Hangzhou city commercial banks, Jinan City Commercial Bank, Nanjing City Commercial Bank, Ningbo City Commercial Bank, Wenzhou City Commercial Bank, and Xi'an City Commercial Bank.

Domestic banks were encouraged by CBRC to list on the foreign stock exchanges monitoring by external entities to improve the Chinese Bank's asset quality and management. For instance, Bank of China (BOC), Bank of Communications (BoCom), China Construction Bank (CCB), Industrial and Commercial Bank of China (ICBC), Minsheng Banking Corp (CMBC) were all listed on the Hong Kong Stock Exchange in turn from 2002 to 2009. Furthermore, the domestic banks listed on the foreign stock exchanges, their shares at there are not restricted by the regulation to have a limitation of maximum 25% foreign ownership.

Table 1 Chinese Banking System Development Timeline

Year	Event
1979	Agricultural Bank of China were established
1984	Industrial and Commercial Bank of China were established
1986	Intra-bank money market were established
1994	Three State policy Banks were established: The Agricultural Development Bank of China, The China Development Bank and The Export-Import Bank of China
1995	Commercial Bank Law and Central Bank Law (Law on the people's Bank of China)
1997	policy was eased to allow the foreign banks in Shenzhen and Shanghai to offer loans to the foreign companies
1998	AMC--Four Asset Management Companies were established to handle the NPL of the Big Four
2000	Credit rating system online in Shanghai
2001	Entering WTO /Permission of inter-bank lending between foreign banks and domestic banks
2002	BOC listed on Hong Kong Stock Exchange
2005	Bank of Communications and China Construction Bank listed on Hong Kong Stock Exchange
2006	Ministry of Finance release new ASBEs / Industrial and Commercial Bank of China listed on the Hong Kong Stock Exchange

2007	Banking System QDII can directly invest in the foreign Stocks Exchange
2008	Banks were allowed to apply for Insurance license/ CBRC issued Guidelines for Commercial Banks Loans Risk Management to release M&A Loans Business of Commercial Banks.
2009	Minsheng Banking Corp listed on the Hong Kong Stock Exchange/ became a member of Financial Stability Board (FSB) and the Basel Committee on Banking Supervision (BCBS)
2010	109 Commercial Banks constructed specialized branches for SMEs
2012	CBRC issued *Rules for regulating the Capital Adequacy Requirement of Commercial Banks*, requires CAR should be 11.5% and 10.5% respectively for main banks and other banks
2013	Alibaba Group launched "Yu'ebao" to absorb consumer's savings.

Source: Chen et al. (2005), KPMG (2006), and People's Bank of China Data

2.2 Regulations

Regulations are made to maintain the healthy operation in Chinese banking sector so that its role as the asset intermediation works. The key objectives of banking regulations are to effectively allocate resources, prevent systematic risk and protect the depositors' interest. Commercial Bank Law and the Law on the people's Bank of China were published in 1995 as the symbol that Chinese banking supervision started to development. After that, CBRC created in 2003 started to build a sound and fledged banking supervision system. To learn lessons from financial crisis in 2008, Chinese banks are regulated and monitored by the Chinese Banking Regulatory Commission with the support from the Central Bank (People's Bank of China) and Ministry of Finance. CBRC officially became a member of the Financial Stability Board (FSB) and the Basel Committee on Banking Supervision (BCBS) in 2009. After that, Chinese banking system adopted the new liquidity requirement transition in the 2009 Basel II and 2011 Basel III. Generally, the nature of Basel II

and Basel III is not changing but with a more restricted requirement, such as the core tier 1 common equity requiring from 2% to 4.5% with 2.5% reserve capital. CRBC released the consultative documents for Chinese banking industry implement new regulatory standard in 2011 to ask for not only more stringent capital requirements, Basel II and Basel III implementation standards, but also emphasising on strengthening banks' internal controls and corporate governance. More specifically, CRBC requires banks to increase the tier 1 common equity requirement by 0.5 percent which have the total common equity requirement as 7.5 percent.

The world banking system is changing due to implementing Basel II and III. It requirement of higher asset quality supervision has some direct effect on the banking financing channel, tools and costs. But it has less influence on the domestic banks due to their traditional operation methods, simple capital structures and lack of using derivatives. In the short-term view, domestic banks have sufficient capital to satisfy the requirement of the regulations and significantly better than the average international level. The raising of securitisation, counterparty risks and operational risks has little influence on the domestic commercial banks. In the long-term view, the diversification business in commercial banks is the trend for commercial banks. Domestic commercial banks are rapidly increasing assets recently, which have massively added the pressure for capital adequacy and liquidity. Notably, the pressure for joint-equity commercial banks and city commercial banks are much higher compares to state-owned commercial banks (the Big Four) which are systematically important banks and too big to fail. Small and medium banks have lower ability to absorb deposits and mainly rely on the inter-bank money market, so adopting Basel II and III is a great challenge for them, the poor performance banks t

this time are facing the possibility of bankruptcy and been taken over.

Moreover, the restricted regulation about minimum capital requirements for banks can influence the bank efficiency (Pasiouras et al., 2009). Pasiouras et al. (2006) indicate that there are negative relationships between capital requirements and banks' performance, Barth et al. (2004) assessed the relationship between capital requirement under Basel II and banking-sector development and efficiency, and find that cost efficiencies were positively affected by the requirements of disclosure and capital. Higher capital requirements were able to lower the possibility of financial distress and reduce the demand for costly risk management activities. However, Blum (1999) indicated that the capital requirements can enhance banks' risk-taking. Pasiouras (2008) found capital requirements are positively related to technical efficiencies but not statistically significant to all samples. VanHoose (2007) and Berger and DeYoung (1997) both argued that capital requirements can influence the cost efficiency due to the returns on asset portfolios and managed resources different. In Chinese banking system, the official supervision approach[2] was mainly used that CBRC as a powerful supervisor enhancing banks' corporate governance and internal corruption. The CBRC requires commercial banks in China to increase their accounting information transparency. Duarte et al. (2008), however, argued that the more disclosure they do the less efficiency they have, by increasing cost of making disclosures or adding labour or time expenditure for prepare disclosure documents.

[2] According to Pasiouras et al. (2009), there are two major supervision methods in the banking system, official supervision approach and private monitoring approach. The official supervision approach is defined as the official supervisors using direct overseeing, regulating and disciplining banking institutions to prevent market failure.

2.3 Chinese Commercial Banks

Notably, there are mainly three types of commercial banks in China with different ownership structures which form three tiers of domestic banks. The Big Four state-owned banks own the first tier, twelve national-level joint-equity banks comprise the second tier and over a hundred city commercial banks in the third tier.

State-owned Commercial Banks

The Big Four state-owned banks, Industrial and Commercial Bank of China (ICBC), the Agricultural Bank of China (ABC), Bank of China (BOC), and China Construction Bank (CCB) owns 66% of the total assets of the industry, 69 of the loans and 66% of deposits in 2001 (Li *et al*., 2001). In addition, in 2013, state-owned commercial banks have RMB 64,756 billion assets which are 44% of the entire industry and 8% increase compared to that in 2012. Moreover, due to the dominate position in Chinese banking system, their market capitalisations are huge and can be ranked in the world banking market. Nowadays, world's largest banks ranking by market capitalisation is leading by Industrial and Commercial Bank of China (ICBC), China Construction Bank (CCB) is the fourth largest and Agricultural Bank of China (ABC) is the sixth (KPMG, 2012).

Joint-equity Commercial Banks

Joint-equity commercial banks are the group growing much faster than stat-owned banks. In 2013, joint-equity commercial banks have RMB 26,172 billion assets in total, approximately 18% of the industry, which was only 12% in 2006. And compare to the asset of joint-equity commercial banks in 2012, it has an 11 percent increase. The Bank of Communications (BOCS) was the first and the largest joint-equity

commercial banks in China followed by the CITIC Industrial Bank, China Everbright Bank, Hua Xia Bank, China Investment Bank, China Minsheng Banking Corporation, Guangdong Development Bank, Shenzhen Development Bank, and Hainan Development bank.

City Commercial Banks

According to the report of KPMG (2012), city commercial banks have continued to merge and develop into larger province banks and regional banks. The consolidation in this sector has improved with the total number of city commercial banks dropping from 147 to 144 in 2012 whereas assets increased 23.67% to RMB123.469 billion from 99.845 billion. In Chinese banking system, over 90 percent financial assets are operating by commercial banks, mainly including: state owned commercial banks (big four), national joint-stock commercial banks, and city commercial banks. The financial transparency of Chinese banks has improved to 100 out of 144 commercial banks disclosing financial information.

The one of the objectives of China Banking Regulatory Commission (CBRC) is to increase banks' assets quality and capability of risk management. According to KPMG (2012) report, with increasing assets quality and risk management ability, city commercial banks are more and more granted operating as provincial or cross-regional offering a wider range of financial services. In 2009, authorised by CBRC, Qiqihar City Commercial Bank, Mudanjiang City Commercial Bank, Daqing City Commercial Bank and Qitaihe City Credit Union merged into Longjiang Bank mainly operating in Heilongjiang Province. City Commercial banks expanded to have trans-regional business can help these banks address the difficult to follow their clients in

different regions and the risk of high concentration ratio in a single city. On the other hand, mergers among different cities in province or cross-province in China may also increase operational risk, such as branch frauds of recent trans-regional branches (ibid).

Table 2 Total Assets for commercial banks in the period 2006-2013 (USD million)

RMB 1billion	2006	2007	2008	2009	2010	2011	2012	2013
State owned commercial banks	24,236	28,007	31,836	40,089	45,882	53,634	60,040	64,756
National joint-stock commercial banks	5,445	7,249	8,813	11,785	14,862	18,379	23,527	26,172
City commercial banks	2,594	3,341	4,132	5,680	7,853	9,985	12,347	13,956
Others	11,675	14,001	17,610	21,215	25,663	31,290	37,708	42,112
Total	43,950	52,598	62,391	78,769	94,259	113,287	133,622	146,996

Source: calculated based on Bankscope Database

2.4 Bank efficiency in China

Recent years, many studies focused on the Chinese bank efficiency. Chen et al. (2005) examines the cost efficiency changes of Big Four banks and smaller banks of majority state-owned banks over the period 1993 to 2000. They find that the Big Four and smaller banks have more cost efficiency compare to the medium sized Chinese banks. However, Kumbhakar and Wang (2005) analyse the period from 1993 to 2002, the results shows the opposite results that The Big Four are less efficient than the joint-equity banks. The paper of Fu and Heffernan (2007) shows the same result that the medium sized joint-stock banks are more cost X-efficiency than the state-

owned commercial banks over the period from 1985 and 2002. A more recent paper of Jiang and Yao (2009) employ stochastic distance function approach to analyse, the result shows the same result over the period of 1995-2005. Furthermore, Davis (2000) studied more than 30 banks on both sides of the Atlantic and found out that it is sometimes an excessive bidding price to acquire the target bank so that the goal of reducing costs cannot be fulfilled.

The banking efficiency analysis of China was more focused on the studies of relationship between X-efficiency and types of bank ownership, whereas there is lack of systematic study on the banks merger efficiency. Wei and Wang (2000) analyse The Big Four Commercial banks and 8 joint-stock banks in 1997 using DEA, the they find the inefficiency of Big Four is caused by technical inefficiency whereas the other banks' inefficiency is caused by diseconomies of scale. Zhang (2003) chooses fixed assets, share capital and other operating expenses as inputs and deposits, loans and profit before tax as outputs to calculate the efficiency of the Big Four, 10 joint-stock banks, 37 city commercial banks using DEA approaches over the period from 1997 to 2001. He finds there are diseconomies of scale in Chinese Commercial banks.

The merger efficiency analysis in China studies seems mostly only study in the period before China entered WTO using DEA. Only one paper using DEA and SFA to analysis, it shows a consistency on efficiency ranking but a significant different on efficiency value (Xu and Shi, 2006). Our study is quite different that we use the stochastic frontier analysis to study the cost efficiency of Chinese Commercial Banks

This paper, focusing on the period more recently from 2006 to 2013 using stochastic frontier analysis to analyse the hypothetical merger banks of Chinese commercial banks, is the new idea that no previous paper have study on.

There are mainly two views on the commercial bank mergers' economic effects. In the first view, M&A in reality normally occurred between a big and high efficient bank and a small and poor efficient bank. Therefore, the big bank can have more resources and extend its technology to increase efficiencies after-merger, which was proven by Berger and Humphrey (1992) that the acquired banks are less cost efficient than the acquirers. On the other hand, Azarchs (1995), Berger & Humprhey (1992), Srinivasan and Wall (1992) and Rhoades (1993) studied that there are no proves to have economic of scale or profit efficiency using bank mergers. Even though efficiency can be improved when their business scope are overlapped, their results cannot prove that Shaffer (1993) presented that nearly half of the bank mergers he used in the sample showed potential cost efficiencies and no cost efficiency for the banks with total assets over US $10 billion.

The theoretical studies for scale efficiencies in the banking sector focusing on the relationship between bank sizes and efficiencies. 28. Noulas, Ray and Miller (1990) pointed out that the banks' efficiencies will decrease when their total assets are in the range from USD 1 to 6 billion and when the total assets exceed US $6billion, banks have diseconomies of scale. Ashton (1998) also supported that with the study on UK banking industry indicating that small banks have higher economies of scale whereas large banks, especially total assets over 5 billion pounds, exists

diseconomies of scale. Budnevich, Franken & Paredes (1998) demonstrated that small banks are able to increase return to scale by mergers, but not large banks.

Berger, Hunter & Timme (1993) studied that the average cost curve in the banking sector is a U-curve and in fact, the medium sized banks are more scale efficient than the large banks. In the literature of banking scale efficiencies, Berger and Humphrey (1997) presented that using banks with total assets smaller than US $1,000 million as sample, the size of banks' assets in the range between US $7.5 and 30 million have the minimum average cost. Using banks over US $1,000 million, the minimum average costs belong to the group with total assets in US 2 to 10 billion. Hence, it is widely accepted that the banks long-term average cost curve is an inverted U-shaped cost curve. Large banks are believed to have no economies of scale but decrease in the return of scale. Some studies, like Berger et al. (1977) claimed that only limited scale efficiency the banks have by closing branches and transfer deposits and loans to the nearby branches and limited cost savings in total (3% of the overall branches costs). Additionally, when the branches are closed, customers may feel inconvenient and transfer their assets and deposits to other banks. The study of Berger and Mester (1997) indicated that banks with asset size between USD 10 and 25 billion, their economies of scale can be 20% of total costs in the 1990s.

2.5 Mergers in China

In the report of European Central Bank (2000), banking industry has faced increasingly risks since 1990s, under the pressure of it, banking institutions using mergers and acquisitions to achieve the goal of diversification and spread risks. This

report also claimed that bank mergers in the worldwide have made the challenge for banking supervision. In addition, the report for Group of Ten (Huizinga et al., 2001) stated that financial resources can be more rational allocated by bank mergers and the banking industry efficiency can be improved as well. Therefore, mergers in the modern banking sector are more like the strategic management methods.

The objectives of mergers in banking sector are: first, it can rapidly increase the capital strength of banks and expand their business scope. For example, HSBC was a Hong Kong local commercial bank using massive mergers in the worldwide to become a well-known global bank. Secondly, banks always use mergers as the strategic development to improve their competitive power and increase earning profit. For instance, Deutsche Bank became a major player after it acquired Bankers Trust in US. Its earning per share was up to Euro 5.05 from 3.5 in 1998 and continued the trend until Euro 9.02 in 2000. Because of this merger, its return on equity has year-on-year growth 39% and investment bank department has 50% profit of the whole institution (compare to what their profit two years ago—29%). In short, Deutsche Bank enhanced its competitiveness and profitability. The third goal for banks to merge is that it is the fastest and best way to extension. HSBC, founded in 1864, has been through several M&A during its development, 1959 merged The Mercantile Bank of India, and acquired 61.5% shares of Hang Seng Bank (second largest bank in Hong Kong) in 1959, in 1980, HSBC takeover Marine Midland Bank in USA and in 1992 purchased Midland Bank over 50% stocks. HSBC has more than 3000 branches in over 70 countries and regions. Because of the reasons above, merger waves have been frequently seen in the financial market. Merger activities are popular as well because it still plays an important role in the banking industry

development.

The financial regulation reforms encouraged mergers and acquisition activities in banking sector. In 1990s, the nature of bank merger was to save banks from bankruptcy rather than make profit and restructuring under the interference of government. For example, in Almanac of China' Finance and Banking 1995-2006 (Press, C. S., 2008), Guangdong Development bank merged TIC of the China Bank in 1996 is based on the circumstance that the TIC of the China bank became insolvent causing by mismanagement and excess debt. Hence, Guangdong Development Bank purchased its shares and stabilized it and protected the interest of both shareholders and debtholders (Hong & Yan, 1997). Additionally, on the January of 1997, China Construction Bank acquired China Agricultural Development Trust and Investment Companies and on December that year, Hainan Development Bank merged 28 Urban Credit Unions.

Since, 1999, marketization guided mergers gradually instead the government interference, the objective of bank mergers is to complement each other's advantages to have more market power. For example, China Everbright Bank (CEB) acquired China Investment Bank in March 1999; ICBC became the controlling shareholders of Union Bank of Hong Kong Ltd. by acquiring 53% stake owned by China Merchants Group in April 2000; Industrial Bank merged Yiwu Urban credit union, Wenzhou Oubei urban credit union, Taizhou Huangyanxunda unban credit union, Foshan city commercial bank in turns during 2001 and 2004. Such bank mergers can extend their scale and earning more market power which have significantly affect the degree of trust from clients in the banking industry. After

entering WTO, the international mergers in banking sector become more interested in domestic banks and focus on the joint-equity commercial banks and well-performed city commercial banks. For example, Nanjing Commercial bank was merged by International Finance Corporation (IFC) in November 2001; Xian Commercial Bank was acquired by International Finance Corporation and the Bank of Nova Scotia in October 2004; July 2005, the German investment and development co., Ltd, German savings bank country cooperation fund and German savings Banks national development fund merged Nanchong Commercial Bank. At the end of 2007, 18 Chinese commercial banks were invested by 26 overseas financial institutions with US $17.9 billion.

Merger has a significant effect on banks strategic management. Initially, it help banks to extend the customer service area, expand network effect, and share achievement of economic growth in high growth areas. The banking mergers always start from such strategic objective. With more network and customer service area, the market shares, clients and revenues increase rapidly. Secondly, merger can help banks to response to the volatility brought by economic cycle. The strategy of world leading banks is to adjust assets and range of business with the wave of economic cycle. When expected economy is weak, they sell assets and shrink business range; when it turns strong, they acquire more assets to expand. Examples of HSBC merged Brazil banks in low price after Latin American financial crisis in late 1990s to earn high return on investments and sold 52 assets in the world to help bank facing the situation of economic growth slowing. Thirdly, it helps bank to shifting its regional strategic focus. High growths in the emerging markets are attractive to banking industry and make them increase their investments in these areas. Standard Charter

bank execute emerging market investment strategy and Temasek Holdings increase its investments in emerging markets including China and have a good return on it. Additionally, with more restricted Basel II and III capital adequacy requirement, banks using mergers to management assets to help capital reservation. When banks have sufficient capital, merger is the measurement to increase return on equity by expanding business area, but when banks short of capital, and under the pressure of limited external financing and more stringent supervision, selling assets is the measurement. At this stage in China, banking merger activities are mainly focusing on the extension of customer service areas in the overseas. For instance, the bank of china which is the banks in China with highest overseas assets has covered countries and regions in the world less than half of that of City Group.

3. Estimation methodology

3.1 Cost function specifications

Cost efficiency measures that how well the performance of a bank is close to the "best-practice" bank producing same outputs under the same environmental conditions. It considers the minimum costs as the determinant of "best-practice" by allowing the comparison between the best practice banks of the industry, taking into account their inputs and outputs. According to SemihYildirim and Philippatos (2007), the general cost function equation should be written as:

$$C(y_{it}, w_{it}, t) \equiv \min_{x_{it}} \left\{ \sum_{m=1}^{M} w_{mit} p_{mit} : y_{it} = F(p_{it}, t) \right\} \quad (1)$$

Where

$y_{it}$is output quantities of bank i in period t, with $y_{it} \in R_{+}^{s}$

$p_{mit}$is inputs price with $p_{it} \in R_{+}^{m}$,

$t$is an index of technological changes,

$F(x_{it}, t)$is the requirements of inputs that to get outputs

Therefore, a translog cost function of the form should be used to estimate as:

$$\begin{aligned} Ln(TC_{ti}) = \; & \delta_0 + \sum_{i=1}^{3} \alpha_i \ln p_{ti} + \frac{1}{2} \sum_{i}^{3} \sum_{j}^{3} \gamma_{ij} \ln p_{ti} \ln p_{tj} + \sum_{m=1}^{3} \beta_m \ln y_{tm} \\ & + \frac{1}{2} \sum_{m=1}^{3} \sum_{n=1}^{3} \sigma_{mn} \ln y_{tm} \ln y_{tn} + \sum_{m}^{3} \sum_{i}^{3} \varphi_{mi} \ln y_{tm} \ln p_{ti} + \emptyset_i t + \tau_i t^2 + \varepsilon_{ti} \end{aligned} \quad (2)$$

Where ε_i is the random error of the *i*th bank at time (t). This paper specification assumes three standard outputs and three input prices, which will be explained in Section 4.

TC = Total costs (Personnel Expenses + Total Interest Expense+ Other Operating Expenses)

p_i = Price of inputs; $(i = 1)$ price of funds, $(i = 2)$ price of labour, $(i = 3)$ other operating expenses over total assets (price of capital)

y_m = Bank outputs; $(m = 1)$ gross loans, $(m = 2)$ other earning assets, $(m = 3)$ off-balance sheet trading and commission income

3.2 Estimating scale efficiencies

In order to analyse the reasons of hypothetical mergers cost saving, the economies of scale of Chinese banking industry is another important focus in this paper. Estimating economies of scale (EOS) as following:

$$EOS = \frac{C(y_{it}, w_{it}, t)}{\sum_i y_{it} MC_{it}} = \frac{\partial \ln C_{it}}{\partial \ln y_{it}} = \sum_{m=1}^{3} \alpha_m + \frac{1}{2} \sum_{m=1}^{3} \sum_{n=1}^{3} \sigma_{mn} \ln \tilde{y}_m + \sum_{m}^{3} \sum_{i}^{3} \varphi_{mi} \ln \tilde{y}_m \quad (3)$$

To Calculate the overall economies of scale, the mean of $\ln \bar{y}$ and $\ln \bar{p}$ should be used to replace the value of $\ln \tilde{y}_m$ and $\ln \tilde{p}_i$. And the economies of scale for each bank i in year t the individual value of $\ln p_{ti}$ and $\ln y_{tm}$ should be adopted.

Hence, $EOS * \sum_i y_{it} MC_{it}$ is the cost elasticity of bank outputs. If the economies of scale of bank i show a result less than 1, it indicates the increasing return to scale. If the EOS larger than 1, bank suffers diseconomies of scale and if EOS is equal to 1, the bank has constant returns of scale. Specifically, one percentage increase in

inputs leads to a less than one percentage increase in costs is indicative of economies of scale.

3.3 Technological changes

In the sample period, the results of cost efficiency may also be affected by technological changes. The technological changes defined by Allen and Liu (2007) as the changes in the banking industry "include financial innovations, changes in the competitive nature of banks, and demographically led changes in household portfolios". Recent years with way of services in banking sectors changes caused by the significant changes in technology, which also changes the instruments for services and financial services players in the markets (Freedman and Goodlet, 1998). It is important to consider the technological changes (t) over the period may have an effect on cost savings of bank mergers. So it is assumed the technological changes cause the changes in cost function directly, which means banks experience the change technological shocks over the sample period. Such shocks are expressed in equation with a quadratic time polynomial. The rate of technological change is given as:

$$\mathrm{TECH} = \left(\frac{\partial \ln \mathrm{C_i}}{\partial \mathrm{T}}\right) \tag{4}$$

In addition, t^2estimates the changes in t. With a positive value in t but negative one int^2, the cost reduce indeed related to the increase in technological change with a diminishing rate. Since it is difficult to follow the exact date of technological changes have the effects on the cost structure, therefore, this method show a non-parametric specification of technological change that not require the changes dates (Allen & Liu, 2007).

3.4 Estimating X-efficiencies

To estimate the X-efficiencies in Chinese commercial bank mergers, we use Stochastic Frontier Analysis (SFA) procedure represents a parametric and a non-parametric technique. According to Berger and Mester (1997), different parametric approaches make limited difference on average efficiency of the banking industry or the ranking of individual bank efficiencies, which is further supported by Bauer et al. (1998) who stated that under the sample major consistence criteria, such as efficiency distribution, efficiency ranking, best and worst bank, it has little influence on the choice of frontier approaches. However, on the other hand, Kohers et al. (2000) claim that different groups of techniques have their own pros and cons. Random errors are allowed by using parameter group of technique which is not in non-parameter group of technique.

Following the sequence of frontier efficiency instructed by Kohers et al. (2000), first, construct an efficiency frontier relying on the accounting data of inputs and outputs variables. Second, using cost efficiency frontier to estimates the efficiency score of each bank which is ranging from 0 to 1. Hence, the higher the efficiency scores, the higher the efficiency level. A bank with an efficiency score equal to 1 indicates most efficient in the banking industry, whereas a bank with an efficiency score close to 0 implies minimum or null efficiency. For instance, if the Bank of China in 2013 has an X-efficiency score equal to 0.60, it presents the 40% increasing space for Bank of China relative to the “best practice” bank.

In the studies of Coelli, Perelman and Romano (1999), a stochastic production frontier is specified with a composed error term. However, the residuals of the model ε_i will be treated as $\varepsilon_{it} = \vartheta_{it} - \mu_{it}$ rather than μ_{it}. Following the methodology of Battese and Coelli (1988), technical efficiency should be predicted involving the conditional expectation of $\exp(-\mu_{it})$using random errorε_{it}. The X-efficiency should be $E[\exp(-\mu_{it})|\ \varepsilon_{it}]$ which reflects the successful degree of bank i at time t to minimize the production costs with the given. Hence, the expression for conditional expectation of $\exp(-\mu_{it})$is :

$$TE = E[\exp(-\mu_{it})|\ \varepsilon_{it}] = \left\{\exp\left[-\mu_{it} + \frac{1}{2}\sigma_*^2\right]\right\} \cdot \left\{\Phi\left[\frac{\mu_{it}}{\sigma_*} - \sigma_*^2\right] / \Phi\left[\frac{\mu_{it}}{\sigma_*^2}\right]\right\} \quad (5)$$

Based on the calculation method of Coelli (1992, 1994), the γ must be lie between zero and one. The likelihood function is expressed as $\sigma_*^2 \equiv \sigma_\vartheta^2 + \sigma_\mu^2$ and $\gamma = \sigma_\mu^2/\sigma^2$

$$\mu_{it} = (1-\gamma)\left[\delta_0 + \sum_{j=1}^{M} \delta_j z_{j,it}\right] - \gamma\varepsilon_{it} \quad (6)$$

Hence, when γ results are close to 0 or 1, the cost efficiency means nothing that all banks are perfectly efficiency or none of them is efficiency. Hence, gamma is better being in the range between 0.2 and 0.7 to make cost efficiency results meaningful.

3.5 Estimating Z-scores

Risk of bankruptcy is used in this paper as another factor should be considered in banks merger cases. The target banks in the mergers are normally with poor performance and after merging by the banks with good performance, the risk for target banks of bankruptcy may decrease if the merger case is successful. In this

study, we adopt z-score to measure a banking organization's risk. Z-score is widely used in the literature as the measure of risk-taking (Tabak et al., 2013; Mercieca et al., 2007; Laeven and Levine, 2009; Craig and Cabral dos Santos, 1997). The probability of bankruptcy of a bank is estimated by z-score as the measurement of risk of failure. According to Spulbăr and Niţoi (2014) and Lepetit et al. (2008), a higher z-score indicates a lower risk of failure, which can improve the level of banks cost efficiency and weaken the variability of inefficiency effect3.

$$\mathrm{Z} = \frac{\mathrm{ROA} + \mathrm{EQ/TA}}{\mathrm{SDROA}} = \frac{\mathrm{ROA} + \mathrm{Equity\ Ratio}}{\sigma_{\mathrm{ROA}}} \tag{7}$$

Where ROA is return on assets, EQ/TA is the equity to total assets and the numerator is the standard deviation of return on assets.

3.6 Selection process for potential bank mergers

The selection processes of my data are following below process:

1. Cost function of this paper contains three inputs and three outputs, in order to make sure sample contains valid number, all account to calculate inputs and outputs should not be "none". To be more specific, Total Assets and Fixed Assets should not be equal to zero; the number of the observations in Gross Loans, Other Operating Assets and Off-Balance Sheet Trading and Commission Income equalling to zero should be deleted. Personnel expenses, Other Earning Expenses and Total Interest Expense should only left the observations with number not equal to 0.

[3] Following Craig and Cabral dos Santos (1997), due to the sample only contains the mergers of banks rather than Bank Holding Companies (BHC), the calculation of z-score for the target bank is simple and used as (6). It should be the same if calculating the bank mergers made by a BHC which owns only one bank. If the merger is made by the multibank BHC, z-score should be computed as a hypothetical bank created using the sum of banks of that multibank BHC.

2. Exclusion of the banks having less than 4 year financial data over the sample period 2006-2013. The total number of banks drops from 124 to 32 due to massive observations' personnel expenses lack of data.
3. Calculation of X-efficiencies of original data and get individual bank's technical efficiency.
4. Calculation of Scale Efficiencies of original data and get individual bank's scale efficiency.
5. Construction of merger banks based on the data of original scale efficiency. When the result of scale efficiency is larger than 1, bank has diseconomies of scale; when the resultis smaller than 1, bank has economies of scale; when the result is equal to 1, the bank has constant return to scale. However, the scale efficiencies with the figure larger than 0.95 is really close to the 1, it is hard to tell whether bank has economies of scales or constant return of scale based on this method. Hence, hypothetical bank mergers will only using the banks with increasing returns to scale (S -EFF < 0.95)
6. Exclusion of the banks having lower than 2 continuous years increasing returns to scale starting from 2007 over the sample 8 years. Hence, the number of banks drops from 32 to 8.
7. a. The banks with economies of scale should be in the same province.

   b. The banks with economies of scale should be in the same geographic region (Table 3) and the Province of Bank A should be next to the province of Bank B if the merger happens in the banks within different province.

   c. Based on this criteria, 7 banks are in the provinces next to each other (at South-eastern of China), only Bank of Fuxin (in Liaoning Province which is in the

North-eastern of China). The number of banks drops from 8 to 7, which is the final banks in the hypothetical mergers.

8. Exclusion of the mergers with the max amount of foreign shareholding in Chinese commercial banks greater than 20%. Based on the information of Bankscope, it seems all commercial banks in this sample after selection are 100% held by Chinese domestic banks and companies[4] in 2014.

Table 3 Geographic Region in China

Geographic regions	Numbers of Provinces	Provinces included
Dongbei Region	3	Heilongjiang, Jilin, Liaoning
Huabei Region	5	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia
Huazhong Region	3	Henan, Hubei, Hunan
Huadong Region	8	Shandong, Jiangsu, Anhui, Shanghai, Zhejiang, Jiangxi, Fujian, Taiwan
Huanan Region	5	Guangdong, Guangxi, Hainan, Hong Kong, Macau
Xibei Region	5	Xinjiang, Gansu, Ningxia, Qinghai, Shaanxi
Xinan Region	5	Chongqing, Sichuan, Guizhou, Yunnan, Xizang

Source: Constitution of the People's Republic of China

[4] Although the literature shows the number of foreign banks merge domestic banks increases after China entered WTO, this sample shows the opposite, the final 7 banks of merger cases are 100% owned by domestic banks or companies.

Table 4 Seven final Banks

Bank ID	Bank Name	Short Name	City	Province
5	Bank of Dongguan	BOD	Dongguan	Guangdong
7	Fujian Haixia Bank Co. Ltd	FJHX	Fuzhou	Fujian
18	Bank of Nanchang Co. Ltd	NCCZ	Nanchang	Jiangxi
19	Nanchong city commercial bank Co. Ltd	CGNB	Nanchong	Sichuan
27	Hankou bank	HKB	Hankou	Wuhan
28	Xiamen international bank	XIB	Xiamen	Fujian
31	China resources bank of Zhuhai Co. Ltd	CRBC	Zhuhai	Guangdong

Source: Author's Summary

4. Data

In order to build the sample of this paper, Chinese commercial banks are selected by location exclude Beijing and Shanghai. According to the report of KPMG (2013), there are 200 commercial banks in total and 124 of them located in the places outside Beijing and Shanghai. The banking systems of Beijing and Shanghai are slightly different to the banks in other locations of China which is mainly because Beijing is the political centre and Shanghai is the financial centre of China, the developing speed on international connection of banking sector was far exceed other places' commercial banks. Therefore, to consider the Chinese overall banking sector, we exclude the Beijing and Shanghai to reduce the bias of results in Chinese Commercial Banks.

124 commercial banks' balance sheets and income statements are downloaded from Bankscope Database, but, due to the purpose of analysing hypothetical mergers, the banks without the figures of gross loans, other earning assets, total assets, off-balance sheet income, personal expenses, total interest expense and other operating expenses are deleted from the sample. At last, 32 banks are chosen over the period 2006 to 2013 with their operating period at least having 4 years over the sample period and are in real terms using the GDP deflator. Choosing 32 banks out of 124 seem to analyse with unbiased and cannot represent the total Chinese banking system. To be noticed, the 32 commercial banks in the sample with the assets over US $8784 billion in the period covered over 55% of all the commercial banks' total assets in China exclude the region Beijing and Shanghai

Table 5 The Total Assets of Commercial banks in population and in sample (US $ Millions)

	Total Assets of 124 Commercial banks	Total Assets of 32 Banks selected	Ratio
2006	346,802	189,074	55%
2007	678,649	416,811	61%
2008	494,834	301,667	61%
2009	1,174,034	643,337	55%
2010	1,887,354	1,258,136	67%
2011	2,650,431	1,612,438	61%
2012	3,490,537	2,077,905	60%
2013	3,466,394	2,284,860	66%

Source: Bankscope Database

It is important to understand this paper focuses on the hypothetical mergers instead of actual mergers in order to guide the potential mergers in Chinese Commercial Banks in the future. According to the research of Hadad et al. (2013), it is inconclusive to use which inputs and outputs in either parametric or non-parametric methods. The previous studies are supporting two different approaches and both arguing following the bank's actual production process. The two approaches are intermediation approaches and production approaches, the first one is using deposits as input (Evanoff and Israilevich, 1995; Rangan et.al., 1988; Berger and Humphrey, 1991) and, the second one, and deposits are treated as outputs (Sherman and Gold, 1985; Ferrier and Lovell, 1990). The proposed model of inputs and outputs is following intermediation approach which treats deposit as inputs to convert into loans, (Mester, 1987; Avkiran, 1999).

Fortunately, in China, the Law of The People's Republic of China on Commercial Bank 1995, which is the operating basis for commercial banks, support the intermediation approach:

> *"the term 'commercial bank' means enterprise legal persons that are establishes in conformity with this law and the Company Law of the People's Republic of China and that take in deposits from the general public, grant loans, handle settlements, etc." (Chapter I Article 2)*

With the clear definition in Commercial Bank Act, deposits should be used as the inputs rather than outputs in China. Therefore, this paper will adopt intermediation approach, three inputs and three outputs, with deposits as inputs -- price of funds (total interest expense / total deposit money market and short-term funding). In addition, the second input is price of labour which is a widely adopted indicator calculated as personnel expenses/ fixed assets (Yao & Jiang, 2010). Other operating expenses / total assets ratio is the final inputs. The Table 6 shows the summary statistics of all variables.

Table 6 Variables summary

Variables	Mean	Stddev	Minimum	Maximum
Outputs				
Gross loans	15.713	1.230	12.522	19.383
Other earning assets	14.798	1.361	9.948	18.373
Off-balance sheet trading and commission income	11.710	1.180	8.034	15.900
Inputs				
Personal expenses/fixed assets	-0.279	0.718	-1.925	2.046
Total interest expenses/ total funding	-3.943	0.355	-4.823	-3.161
Other operating assets / total assets	-6.416	1.133	-11.899	-3.934
Dependent Variable				
Total Costs	12.954	1.360	10.099	16.804

Source: Author's Calculation

5. Estimation and Results

This part will discuss the efficiency results for Chinese commercial banks hypothetical mergers and consider the possibilities of them to use merger reduce cost in the sample period 2006 to 2013. Table 7 presents the summary of actual technological changes, x-efficiencies, scale inefficiencies and z-scores.

The results in Table 6 show Chinese Commercial banks technological change has significant effect on the banks cost savings, with a positive 0.205 coefficient on *t* but a negative 0.0435 coefficient on *t2* which is the square of *t*. It indicates that one percent change in technological changes results in a 20.5 percent decrease in costs, but this cost savings having a diminishing rate at 4.35 percent per year. Hence, Chinese commercial banks should try to improve their technological implementation to support themselves reducing costs, such as mobile banks or more branches and ATMs in the rural areas. To be noticed, companies such as Alibaba and Tencent launched their own internet finance product in turns after 2013, which have a great impact on market concentration of the traditional commercial banks.

Table 7 Technological changes, x-efficiencies, scale inefficiencies and z-scores estimates

	Estimate	Standard Error	*t*-Statistic
A. Technological Change Estimates			
T	0.2050	0.0405	5.0600
T2	-0.0435	0.0067	-6.5100
B. X-efficiencies estimates			
Minimum	40.62	Maximum	99.88
Mean	92.74	Std. deviation	15.47
C. Scale Inefficiencies Estimates			
Minimum	0.18	Maximum	74..72
Mean	14.38	Std. deviation	12.28
D. Z-scores Estimates			
Minimum	-0.27	Maximum	8.54
Mean	2.70	Std. deviation	1.01

Source: Authors' calculations

5.1 Examination of scale economies and X-efficiency of pre-merger banks results

Table 8 presents the Chinese commercial banks' X-efficiency over the sample period from 2006 to 2013. It seems that banks from 2006 to 2008 have the low x-efficiency with many of them lack of data disclosed and after 2009, most commercial banks of china show their x-efficiency close to 1. Majority banks have the x-efficiencies equal to 1 means these banks are on the curve of returns to scale. Combining with the results in Figure 1, it provides that all figures with low x-efficiencies are in the period from 2006 to 2008 with the efficiency level at around 40%, 60% and 80% correspondingly. Before 2009, the accounting standards for un-listed commercial banks were not very restricted, hence, many banks' information, without the similar requirements as listed banks, were undisclosed. In 2009 regulations in the banking

industry was changed to require more transparency accounting disclosure and CBRC release the Basel II liquidity requirement. The different results between 2006-2008 and after 2009 may be responding to such changing regulations in china with more restricted requirement of accounting information transparency. As claimed that CBRC requires banks to increase internal control and corporate governance to increase asset quality, the X-efficiencies increase since 2009 proves it. The higher x-efficiencies they show, the lower inputs they use to get same amount of outputs. Therefore, under the effective regulations, Chinese commercial banks indeed increased their x-efficiencies during the sample period 2006 to 2013.

Using the fifth bank in the list of Table 7 as an example, Bank of Dongguan, has the complete data from 2006 to 2013. It x-efficiency has been increased gradually from approximately 41.05% in 2006 to 80.29% in 2008, and after 2009, the x-efficiencies of this bank was stabled at over 99% which is very close to 1. In March 23, 2008, Dongguan City Commercial Bank was renamed to Bank of Dongguan. Its nature of banking was also changed from city commercial banks to joint-stock commercial banks. After this changing, Bank of Dongguan extended its business scope to have trans-regional business and improved its financial service ability to the local society. Its competitive advantages in the local financial institutions, was also raised during the period 2008 to 2009. In addition, according to the credit ranking analysis report made by Yang (2009), Bank of Dongguan was rated as AA^{-}. Under the incentive of severe financial crisis in the Dongguan city, Bank of Dongguan had a structure adjustment to increase the monitor for their business, enhance the managing activities post-loans and raise the loan loss provision level. Bank of Dongguan (2008) also announced that they implemented a project called, ”a hundred days internal

check", to reduce internal redundancy operations and increase overall performance. These all improvements Bank of Dongguan made after 2008 help this bank to decrease its costs level and increase its efficiency level.

These 32 selected commercial banks should be ranked by efficiency level to see the individual performance in the industry. One way to do it is using efficiency scores which are the results we get in Table 8. There is another way to measure it called Berger Efficiency is the ranking method we used in this article (see Table 9). Berger et al. (2009) claim that efficiency ranking is a better measurement than efficiency scores to rank the banks' cost efficiency across time more comparably. Therefore, we convert our results of average efficiency score into the Berger's efficiency. Specially, the ranks are in the range from 0 to 1, the formula of this is: (order -1) / (n-1). As the order is the average ranking efficiencies from 1 to n where n is the number of banks. Therefore, bank with lowest ranking is equal to 0 as (1-1) / (n-1) and bank with greatest ranking is equal to 1 as (n-1) / (n-1). Bank i's efficiency rank shows that the proportion of other sample banks in the period with lower efficiency level. For example, Bank of Chengdu is better than 90% of the industry banks with a rank of 0.90. Moreover, the results of this table also support the statements of Berger that his method is better than efficiency scores. Generally, the ranking results of efficiency scores are in the same trend with Berger ranking but less accurate. The top five banks ranking by Berger have the same average efficiency scores equal to 0.9984 and the next seven banks' average efficiency scores are all equal to 0.9983.

Still see Bank of Dongguan as an example to analyse, we see that its average efficiency score equals to 0.8531 which means that this bank's x-inefficiency level is

14.69% much higher than the average x-inefficiency of the industry (7.26%). Berger's ranking shows that Bank of Dongguan was performed only better than 13% banks of the industry (rank: 0.13). Hence, if we just consider the influences of x-efficiencies in the banking sector, the bottom banks of this list should be focused to increase their cost efficiencies.

Figure 2 shows the scale efficiencies which is the inverse U-shaped cost curve with all range of total assets (in log) in Chinese commercial banks. It appears that banks are economies of scale with higher level of banks' total assets and its return to scale decrease. Figure 3 presents the scale inefficiencies which are correlated to the results of Figure 2. The largest scale inefficiency 74.72% is the results of the smallest Chinese commercial bank but have the best increasing return to scale (See Table 7) and the Chinese banking industry average scale inefficiency is 14.38%. Therefore, using mergers to increase total assets, with the high scale inefficiency in the small Chinese commercial banks can be reduced dramatically. However, the average scale inefficiency of Chinese banking system is still higher than that of Japanese banks and Indonesian banks with 6.8% in 1996 and 4.4% in 2004-2009 respectively, which means the entire level of Chinese banking industry are much more scale inefficiency to compare to these Asian countries. Hence, in order to reduce the scale inefficiencies, it needs banks to increase its assets level and move the scale efficiency curve to the maximum point with constant return to scale (scale efficiency). Therefore, at this point, the scale inefficiency of the bank will drop to the minimum.

Therefore, x-efficiencies in the Table 7 indicate that banking industry has the cost efficiency level as high as 92.74% and its x-inefficiency is 7.26%. See through Figure 1, the x-efficiencies of the Chinese commercial banks seems have no relationship to the banks' assets. The highest X-inefficiencies are 59.38% but the lowest ones are 0.12%. Therefore, the overall inefficiencies in Chinese commercial banks are mainly caused by the scale inefficiencies (14.38%) but not X-efficiencies (7.26%) and higher cost efficiencies of Chinese Commercial Banks can be achieved by mergers with better economies of scale and larger total assets.

Nanchong city commercial bank Co., Ltd. is the bank with average x-efficiency equals to 0.9983 which is better than 77% banks in the industry but its average scale efficiency is 0.7802. According to the analyse above, the cost inefficiencies of Chinese banking industry is mainly caused by scale efficiencies, hence, Nanchong city commercial bank Co., Ltd is the bank we use in the hypothetical merger case to increase its cost efficiencies. In reality, Nanchong city commercial bank (Sichuan Province) was authorised by CBRC to establish the first trans-provincial branch in Guizhou Province on September 17, 2009. It founded another branch in Bazhong city, Sichuan Province. During the sample period from 2009 to 2013 for this bank, it has transferred itself from a city commercial bank to a trans-regional modern bank. Although this bank had activities to become a trans-regional bank, its scale efficiency level was low in that period. One possible reason for this may be that Nanchong city commercial bank did not expand its operational scope by mergers and simply established a branch in the new area was a strategy lack of competitive advantages. One of the biggest benefits of mergers is that it has synergy effects. For instance, NanChong city commercial bank can combine with poor performance bank in the

target market -- which is relatively easier to takeover – to increase its scale efficiency more effectively by using the target market bank's existing clients and network. The two poor scale efficiencies banks merge together is also the main hypothetical merger method we use in the next section.

In addition, China Guangfa Bank Co Ltd in 2006 has the minimum z-score equal to -0.27 which indicates highest level of bankruptcy risk in the banking system. However, with X-efficiency more and more equal to 1 (See Table 8), its cost efficiency increase, the z-score has increase from -0.27 in 2006 to 2.39 in 2012 which is close to the average z-score in the whole banking industry. It seems that the changing of banking performance from high bankruptcy risk possibilities to low in the sample period have no relationship with asset growth. The scale efficiency of this bank shows diseconomies of scale from 1.0718 in 2006 to 1.0426 in 2013. On the other hand, as cost efficiency of banking is generally more related to the scale efficiency rather than x-efficiency, China Guangfa Bank Co Ltd can shrink its assets size to decrease its diseconomies of scale to the optimal point with constant return to scale.

Table 8 X-efficiency of all Chinese Commercial Banks over the sample period 2006-2013

Bank Name	Bank ID	2006	2007	2008	2009	2010	2011	2012	2013
Bank of Jilin Co Ltd	1				0.9978	0.9980	0.9984	0.9987	
Bank of Chengdu Co Ltd	2					0.9980	0.9984	0.9987	0.9985
Chongqing Rural Commercial Bank	3					0.9980	0.9984	0.9987	0.9985
Bank of Dalian	4		0.6172	0.7929		0.9980	0.9984	0.9987	0.9986
Bank of Dongguan	5	0.4105	0.6201	0.8029	0.9978	0.9980	0.9984	0.9987	0.9986
Bank of Fuxin Co. Ltd	6				0.9979	0.9980	0.9984	0.9987	
Fujian Haixia Bank Co Ltd	7		0.6318	0.8264	0.9978	0.9980	0.9984	0.9987	0.9985
Industrial Bank Co Ltd	8					0.9981	0.9984	0.9987	0.9985
Guangxi Beibu Gulf Bank Co Ltd	9					0.9979	0.9984	0.9987	0.9986
Bank of Guangzhou Co,, Ltd	10				0.9978	0.9980	0.9984	0.9987	
China Guangfa Bank Co Ltd	11	0.4228	0.6160	0.7957	0.9978	0.9980	0.9984	0.9987	0.9986
Guangzhou Rural Commercial Bank Co., Ltd.	12					0.9980	0.9984	0.9987	0.9986
Bank of Guiyang Co Ltd	13				0.9978	0.9980	0.9984	0.9987	
China Zheshang Bank Co Ltd	14		0.6230	0.7986	0.9978	0.9981	0.9984	0.9987	0.9985
Jiangsu Jiangyin Rural Commercial Bank	15				0.9978	0.9981	0.9985	0.9987	0.9986
Qilu Bank co ltd	16				0.9978	0.9981	0.9985	0.9987	0.9986
Fudian Bank Co Ltd	17		0.6104		0.9978	0.9980	0.9984	0.9987	0.9985
Bank of Nanchang co., Ltd	18		0.6180	0.8077	0.9978	0.9980	0.9984	0.9987	0.9986
Nanchong City Commercial Bank Co., Ltd	19				0.9979	0.9981	0.9984	0.9987	0.9985

Bank of Nanjing	20		0.6232		0.9978	0.9980	0.9984	0.9987	0.9985
Bank of Ningbo	21	0.4151	0.6217	0.7975	0.9978	0.9980	0.9985	0.9987	
Bank of Qingdao Co Ltd	22				0.9978	0.9980	0.9984	0.9987	
Shengjing Bank	23				0.9978	0.9980	0.9984	0.9987	0.9986
China Merchants Bank Co Ltd	24	0.4262	0.6148	0.7743	0.9978	0.9980	0.9984	0.9987	0.9986
Bank of Tianjin	25				0.9979	0.9981	0.9984	0.9987	0.9985
Bank of Wenzhou Co Ltd	26	0.4220	0.6205	0.7893	0.9978	0.9980	0.9984	0.9987	0.9986
Hankou Bank	27	0.4062	0.6176	0.7995	0.9978	0.9980	0.9984	0.9987	0.9986
Xiamen International Bank	28		0.6422	0.8452		0.9981	0.9984	0.9987	0.9986
Bank of Yingkou	29	0.4279	0.6181	0.8026	0.9978	0.9979	0.9984	0.9987	0.9985
Qishang Bank.	30		0.6210		0.9979	0.9981	0.9985	0.9987	
China Resources Bank of Zhuhai Co Ltd	31		0.6149		0.9978		0.9984	0.9987	0.9985
United Overseas Bank (China) Limited	32		0.6172		0.9978	0.9981	0.9984	0.9988	0.9986

Source: Based on author's calculations

Table 9 Rankings of efficiency from 2006 to 2013

Bank Name	Average ranking Eff	Average efficiency score	Berger ranking
Industrial Bank Co Ltd	8	0.9984	1.00
Guangzhou Rural Commercial Bank Co., Ltd.	12	0.9984	0.97
Chongqing Rural Commercial Bank	3	0.9984	0.94
Bank of Chengdu Co Ltd	2	0.9984	0.90
Guangxi Beibu Gulf Bank Co Ltd	9	0.9984	0.87
Qilu Bank co ltd	16	0.9983	0.84
Jiangsu Jiangyin Rural Commercial Bank	15	0.9983	0.81
Nanchong City Commercial Bank Co., Ltd	19	0.9983	0.77
Bank of Tianjin	25	0.9983	0.74
Shengjing Bank	23	0.9983	0.71
Bank of Fuxin Co. Ltd	6	0.9983	0.68
Bank of Jilin Co Ltd	1	0.9983	0.65
Bank of Qingdao Co Ltd	22	0.9982	0.61
Bank of Guiyang Co Ltd	13	0.9982	0.58
Bank of Guangzhou Co,, Ltd	10	0.9982	0.55
Bank of Nanjing	20	0.9358	0.52
United Overseas Bank (China) Limited	32	0.9348	0.48
Fudian Bank Co Ltd	17	0.9337	0.45
Qishang Bank.	30	0.9228	0.42

China Resources Bank of Zhuhai Co Ltd	31	0.9217	0.39
Fujian Haixia Bank Co Ltd	7	0.9214	0.35
Bank of Nanchang co., Ltd	18	0.9167	0.32
China Zheshang Bank Co Ltd	14	0.9162	0.29
Xiamen International Bank	28	0.9135	0.26
Bank of Dalian	4	0.9006	0.23
Bank of Yingkou	29	0.8550	0.19
China Guangfa Bank Co Ltd	11	0.8532	0.16
Bank of Dongguan	5	0.8531	0.13
Bank of Wenzhou Co Ltd	26	0.8529	0.10
Hankou Bank	27	0.8518	0.06
China Merchants Bank Co Ltd	24	0.8509	0.03
Bank of Ningbo	21	0.8325	0.00

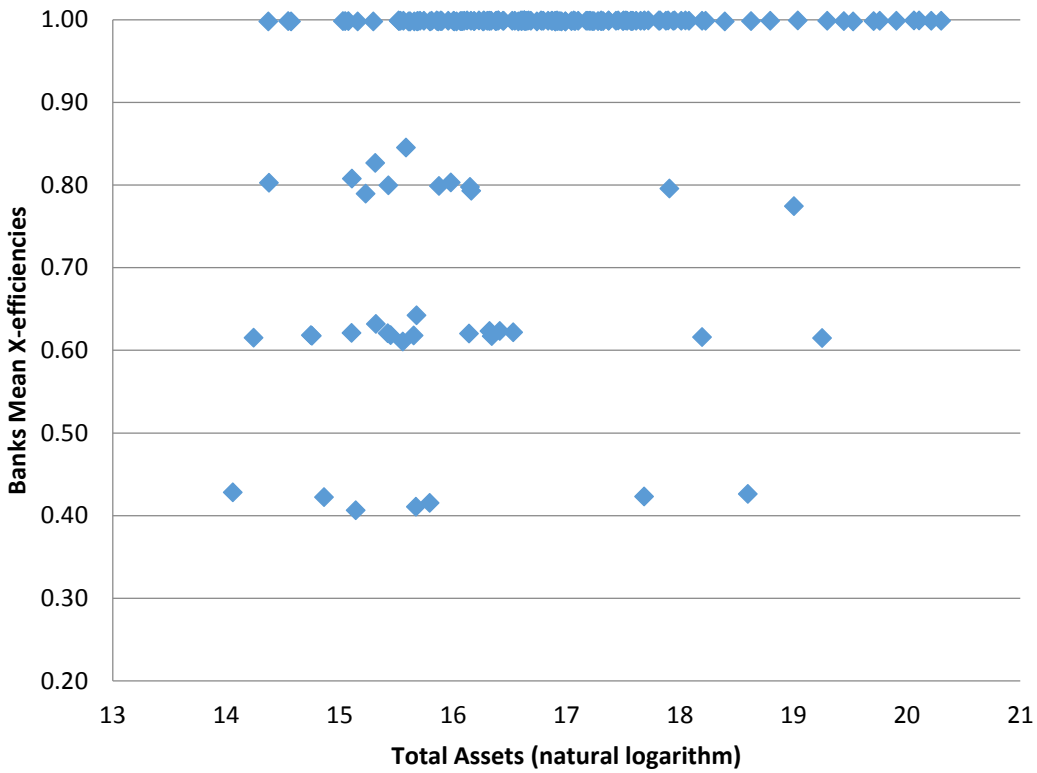
According to Berger (2009), efficiency can be ranking in the order of banks' cost efficiency levels in each year. The ranks can be converted to a uniform using the formula: $(order_i - 1)/(n - 1)$. Where order is the average efficiency ranking and n is the number of banks.

Table 10 Scale efficiencies of all Chinese Commercial Banks over the sample period 2006-2013

Bank Name	Bank ID	2006	2007	2008	2009	2010	2011	2012	2013
Bank of Jilin Co Ltd	1				1.1187	1.1019	1.1140	0.9768	
Bank of Chengdu Co Ltd	2					1.1321	1.0673	1.1178	1.0741
Chongqing Rural Commercial Bank	3					1.2978	1.2938	1.2619	1.2500
Bank of Dalian	4		1.0280	1.0451		1.1672	1.0749	1.0664	1.0689
Bank of Dongguan	5	0.8557	0.8373	0.9825	0.8840	1.0943	1.1933	1.1286	1.2322
Bank of Fuxin Co. Ltd	6				0.8655	0.8246	1.0066	0.8892	
Fujian Haixia Bank Co Ltd	7		0.9286	0.9022	0.9718	0.7856	0.9078	0.8734	0.9933
Industrial Bank Co Ltd	8					1.1459	1.1244	1.0521	0.9896
Guangxi Beibu Gulf Bank Co Ltd	9					0.8621	0.8228	1.0398	1.1088
Bank of Guangzhou Co,, Ltd	10				1.2256	0.9284	1.0763	1.0276	
China Guangfa Bank Co Ltd	11	1.0718	1.0417	1.1046	1.1239	1.2279	1.1376	1.0925	1.0426
Guangzhou Rural Commercial Bank Co., Ltd.	12					1.0520	0.9769	0.9572	1.0194
Bank of Guiyang Co Ltd	13				0.9617	0.9819	1.0147	1.0387	
China Zheshang Bank Co Ltd	14		1.1044	0.9485	1.0696	1.1799	1.1853	1.2530	1.1358
Jiangsu Jiangyin Rural Commercial Bank	15				1.0639	1.1066	1.0761	1.1269	1.1164
Qilu Bank co ltd	16				0.9724	1.1553	1.0990	1.0797	1.0997
Fudian Bank Co Ltd	17		0.9400		0.9982	1.0649	1.1584	1.1888	1.1527
Bank of Nanchang co., Ltd	18		0.8033	0.7758	0.8287	0.8368	0.7008	0.7299	0.7340
Nanchong City Commercial Bank Co., Ltd	19				0.7200	0.8672	0.6760	0.8371	0.8005

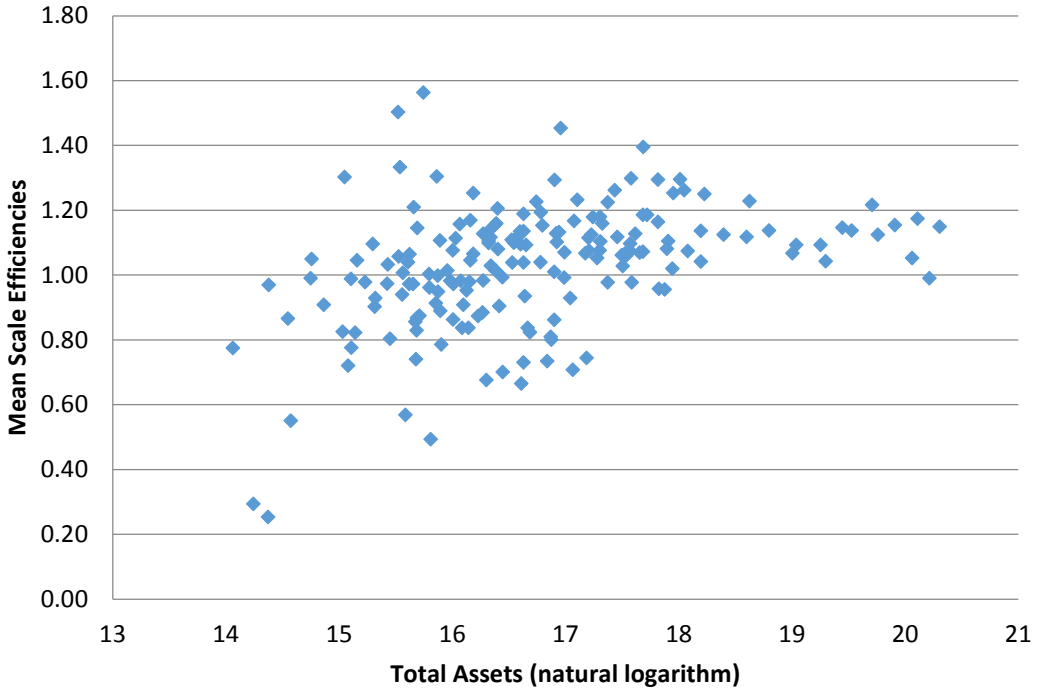
Bank of Nanjing	20		0.9039		1.0097	1.1591	1.1271	1.1635	1.0741
Bank of Ningbo	21	1.0025	1.0382	0.9787	0.9915	1.0611	1.0605	1.0806	
Bank of Qingdao Co Ltd	22				1.2096	1.1568	1.1346	1.1344	
Shengjing Bank	23				1.4536	1.1242	1.2239	1.1857	0.9555
China Merchants Bank Co Ltd	24	1.1169	1.0930	1.0665	1.1374	1.2165	1.1540	1.1736	1.1494
Bank of Tianjin	25				1.2935	1.1791	1.2612	1.3950	1.2954
Bank of Wenzhou Co Ltd	26	0.9077	0.9729	0.9776	1.0392	1.3036	1.1683	1.2049	1.0930
Hankou Bank	27	0.8216	0.9725	1.0320	1.1130	0.9346	0.8612	0.7070	0.7443
Xiamen International Bank	28		0.7397	0.5684		1.2530	1.1351	1.1034	1.0968
Bank of Yingkou	29	0.7747	0.9901	0.9691	1.0449	1.1451	1.0135	0.9525	0.9829
Qishang Bank.	30		0.9876		1.0953	1.0575	0.8742	0.9129	
China Resources Bank of Zhuhai Co Ltd	31		0.2938		0.2528		0.4932	0.6653	0.8087
United Overseas Bank (China) Limited	32		1.0495		0.5503	1.3020	1.3326	1.5023	1.5628

Source: Based on author's calculations



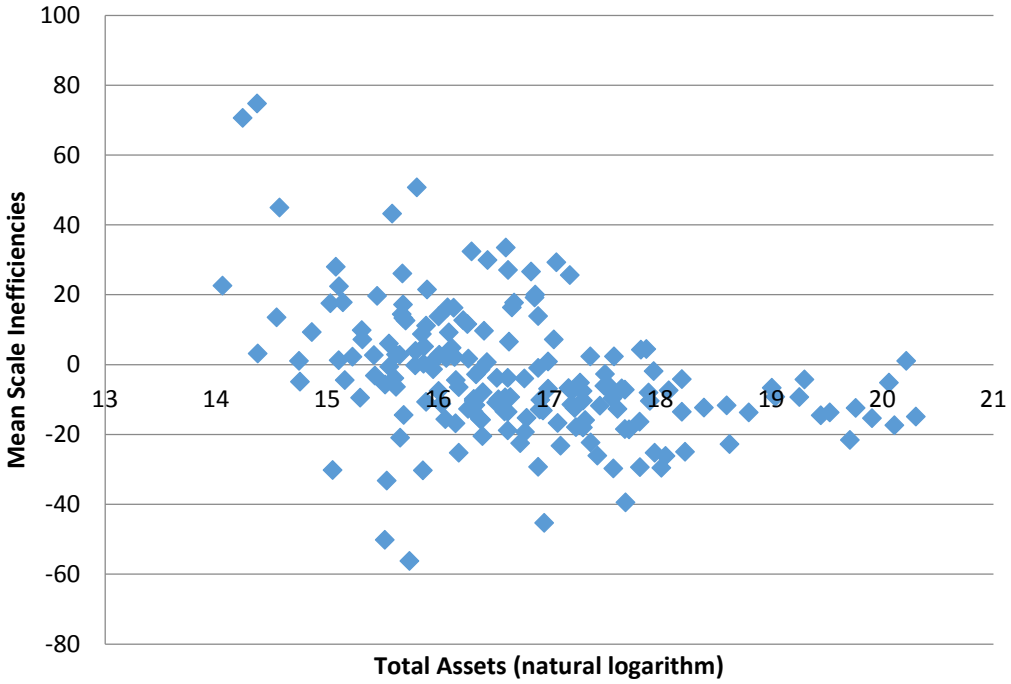
Source: Based on author's calculations

Figure 1 X-efficiencies of Chinese commercial banks 2006-2013



Source: Based on author's calculations

Figure 2 Scale efficiencies of Chinese commercial banks 2006-2013



Source: Based on author's calculations

Figure 3 Scale inefficiencies of Chinese commercial banks 2006-2013

5.2 Examination of hypothetical merger cost savings

The potential cost savings situation of the hypothetical merger cases in the sample are presented in the Table 11. There are 7 banks satisfied the selection criteria of this paper but only 10 possible merged parings under the restriction of the region of the merged banks should be in the same or next to each other. The analysis is in the steps that: at first, in every case, the individual actual total costs of the two potential banks are calculated as constant value plus merged bank's variables multiply its coefficient, shown as follow:

$$TC = cons + \alpha_i \ln p_{ti} + \gamma_{ij} \ln p_{ti} \ln p_{tj} + \beta_m \ln y_{tm} + \sigma_{mn} \ln y_{tm} \ln y_{tn} + \varphi_{mi} \ln y_{tm} \ln p_{ti} + \emptyset_i t + \tau_i t^2 \quad (8)$$

Then using the same method, the sum of total actual cost is $\mathrm{TC}^{\mathrm{Actual}} = \mathrm{TC}_1 + \mathrm{TC}_2$. From the estimated cost function frontier in equation (2), the potential bank can be calculated using the same method equation (7) as $\mathrm{TC}^{\mathrm{Estimated}}$. The cost saving amount of this potential bank can get the gains or losses from merger. Hence, the equation of this economic efficiency should be $\mathrm{EFF} = \mathrm{TC}^{\mathrm{Actual}} - \mathrm{TC}^{\mathrm{Estimated}}$.The obtained economic efficiency figures are shown in the Table 11 Part 1.

In order to help us make vertical comparison among banks, we allow all hypothetical bank merger cases happened in 2007 exclude CGNB+HKB (merged in 2009), due to this potential bank lack of data in 2007 and 2008. If the result of bank *i* in year *t* presents positive, its costs increase; but if the result present negative, bank has a cost decrease. In these ten potential banks, eight banks successfully have overall cost savings after merger during the sample period. These potential bank mergers have the total cost savings US 3.69 billion throughout the period 2006 to 2013. As the total assets of the sample banks during this periods is US 8.78 trillion, the merger activities can cut the industry's total costs to total assets ratio by 0.34%.

Two hypothetical merged banks (FJHX+NCCZ and NCCZ+HKB) both help the original banks reduce their costs over US 1 billion. The potential bank FHJX+NCCZ has a total cost savings US 1.35 billion in 2007 to 2013, it total costs in this period is US 2.81 billion, hence, this merger save these banks' total costs over 48%. Similarly, the total costs of bank NCCZ+HKB equals to US 4.23 billion with its cost saving is US 1.097 billion from 2006 to 2013, this merger case saving them 26% of its cost. Interestingly, the actual Fujian Haixia Bank Co Ltd (FJHX) was authorised to start its trans-regional operation from a local bank to become a regional bank in 2007. Its

branches cover not only Fuzhou city and Fujian Province, but also the cities outside Fujian province, such as Zhangzhou, Wenzhou and etc. According to the bank's annual report, its total assets increased 10.74 billion (34.9%) to RMB 41.53 billion in 2009, and eventually reached 84.35 billion in 2013, which increased about 103.11%. This bank was on the inversed U-shaped curve like Figure 2 that increased its total assets to improve its scale efficiencies from 0.9286 in 2009 to 0.9933 in 2013. However, its scale efficiencies were much below the curve in year 2008 which S-Eff equal to 0.9022, and in year 2010 to 2012 respectively equal to 0.7856, 0.9078 and 0.8734. These results are consistent with the conclusion we said on section 5.1 that the banks' cost efficiencies are more relied on the scale efficiencies rather than technical efficiencies. Look at its x-efficiencies results, we can see that Fujian Haixia Bank Co Ltd has its efficiency scores closely move to 1 yearly and remain stable after 2009. As far as we see this bank is significant to influence the cost savings results of case number 1, 3, 5 and 6, exclude case number 1, all the other threes' annual cost saving results were affected by the changes of scale efficiencies. For example, FJHX+NCCZ, number 3 hypothetical merged bank has its increased cost changing from US $106.708 million in 2007 (scale efficiencies = 0.9286) to US $2.077 million in 2008 (scale efficiencies = 0.9022), and also from 2010 to 2012, cost savings changed from US $357.958 million to US $824.751 million to US $243.041 million (scale efficiencies are 0.7856, 0.9078 ad 0.8734 correspondingly).

Bank of Nanchang Co. Ltd was started its trans-regional operations since 2012 focusing on not only its local branches, also Suzhou and Guangzhou branches. According to the NCCZ's annual report, the performance of Suzhou and Guangzhou branches was poor since 2012 with only 7.29% deposit absorption proportion in

Guangzhou as an example. Additionally, its non-performing loans raised 47.99% from 2011 RMB 433.43 million to 2012 RMB 641.444 million including secondary loans, doubt loans and loss loans. Furthermore, according to the regulation launched in 2013, Document No. 20 “the notice about enhance management on the foreign currency inflows” clearly required the foreign currency deposit to loans ratio lower than 75% whereas Bank of Nanchang was about 85% in 2012. There are so many troubles this bank faced that caused its very poor scale efficiencies and also, it looks odd that its x-efficiencies were so high that over 0.998 in 2012 and 2013.

Six banks (BOD+CRBC, BOD+FJHX, FJHX+CRBC, CGNB+HKB, NCCZ+BOD, NCCZ+CRBC) have the potential to save costs between US 100 million and US 1 billion. However, two potential banks (FJHX+XIB and NCCZ+XIB) involve the increase in costs in US 248 million and US 511 million respectively. The bank XIB seems the bank which causes these two potential banks both under such condition with their cost increase. For example, bank FJHX, can reduce banks costs in the amount range from cost savings US 756 million to US 1.36 billion. But within the merger with Bank XIB, the cost turns to increase massively around US 248 million. Xiamen International Bank converted from a joint Chinese-foreign bank to a Chinese-owned commercial bank entirely in 2013. Due to China entering WTO, the policy advantages of Xiamen International Bank as a joint Chinese-foreign bank was eliminated. In addition, Xiamen International Bank have no license to operating RMB retails, they can only absorb company deposits or insurance without individual deposits. At that time, this bank’s inputs were relatively low which result in low outputs. In order to get out of trouble, Xiamen International started to reform its shareholders’ structure since 2009 and completed in 2013 to maintain its foreign

ownership below 25%. We can see from Table 8, Xiamen International Bank has its x-efficiencies as low as 0.6422 and 0.8452 in year 2007 and 2008 respectively. The efficiency level is much higher during the reform and almost equalled to 1 from 2009 to 2013. For example, in 2011, its foreign shareholder Japanese Shinsei Bank transferred its all 10% ownership to Fujian Investment and Development Group (6.15%) and Xiamen Construction and Development Group (3.85%). In the meantime, it increased 56 new investors with issuing 93,534 million additional shares to decrease the foreign shareholders'' level below 25%. Hence, it is reasonable to have massive cost increase when have merger activities during the period of the shareholder structure reform.

Table 11 Part 2 shows the results that most of these potential banks have reduced its scale inefficiencies compare to the results pre-merger. For example, the best cost savings banks have its scale inefficiencies fallen to 35.36%, which is well lower than the results of pre-merger banks 63.72% and 159.06%. However, these results in the tables are all much higher than the mean of the industry 14.38%. Hence, we can see through these banks all have the potential of cost savings by mergers and improve their profitability. There is one bank, FJHX+XIB, who has the scale inefficiency increase greatly from pre-merger 63.72% and 128.02% to 214.24%. In addition, Spulbăr and Niţoi (2014) and Lepetit et al. (2008) state that a higher z-score indicates a lower risk of failure, which can improve the level of banks cost efficiency and weaken the variability of inefficiency effect .The results of z-score in these ten hypothetical banks are all rising to a higher value which means their risk of failure has decreased.

Table 11 Hypothetical bank merger cost savings

Part 1

Number	Hypothetical bank merger	Cost Saving (-ve) (USD thousands) 2006	2007	2008	2009	2010	2011	2012	2013	**2007-2013**	Gamma(γ)
1	FJHX+XIB		115,287	-45,222		-3,401	-47,205	-412,919	642,161	**248,701**	0.7361
2	BOD+CRBC		-23,793		-180,321		-41,161	179,633	-266,254	**-331,896**	0.0789
3	FJHX+NCCZ		106,708	2,077	40,495	-82,643	-357,958	-824,751	-243,041	**-1,359,113**	0.2885
4	NCCZ+XIB		177,951	516,158		125,909	213,156	-47,618	-474,396	**511,160**	0.6670
5	BOD+FJHX		150,807	25,581	-96,269	-92,636	-104,670	-73,464	-80,858	**-271,509**	0.6576
6	FJHX+CRBC		91,055		95,009		-243,812	-642,272	-56,513	**-756,533**	0.7934
7	CGNB+HKB				-15,212	-52,282	-122,444	-119,718	37,284	**-272,372**	0.4618
8	NCCZ+HKB		112,617	19,939	-67,447	-127,988	-300,969	-600,980	-132,043	**-1,096,871**	0.1411
9	NCCZ+BOD		142,250	103,917	-181,012	-148,516	-37,156	227,368	-239,909	**-133,059**	0.6165
10	NCCZ+CRBC		48,927		-27,749		-80,051	-86,729	-83,506	**-229,108**	0.6535

7 Banks are in this hypothetical merger tables:Bank of Dongguan (BOD), Fujian Haixia Bank Co. Ltd (FJHX), Bank of Nanchang Co. Ltd (NCCZ), Nanchong city commercial bank Co. Ltd (CGNB), Hankou bank (HKB), Xiamen international bank (XIB), and China resources bank of Zhuhai Co. Ltd (CRBC). More detail is in the **Appendix 1.** They are selected from 32 banks with more than 2 years continuous increasing return to scale starting from 2007. The combination of hypothetical merger of these seven banks should be more than 21 possible merged pairings. However, due to our selection criteria in 3.6 (7), the merged banks should be in the province next to each other if there is a cross-regional merger. Hence, the final merger cases are ten. Source: Based on author's calculations

Part 2

Hypothetical bank merger	SINEFF		z-score	
	Before	After	Before	After
FJHX+XIB	FJHX = 63.72 XIB = 128.02	214.24	FJHX = 19.31 XIB = 11.10	24.40
BOD+CRBC	BOD = 108.9 CRBC = 248.62	10.52	BOD = 24.23 CRBC = 15.35	30.11
FJHX+NCCZ	FJHX = 63.72 NCCZ = 159.06	35.36	FJHX = 19.31 NCCZ = 22.37	40.16
NCCZ+XIB	NCCZ = 159.06 XIB = 128.02	44.49	NCCZ = 22.37 XIB = 11.10	28.59
BOD+FJHX	BOD = 108.9 FJHX = 63.72	46.60	BOD = 24.23 FJHX = 19.31	39.70
FJHX+CRBC	FJHX = 63.72 CRBC = 248.62	32.37	FJHX = 19.31 CRBC = 15.35	27.59
CGNB+HKB	CGNB = 109.93 HKB = 110.37	31.62	CGNB = 19.91 HKB = 18.15	32.20
NCCZ+HKB	NCCZ = 159.06 HKB = 110.37	47.33	NCCZ = 22.37 HKB = 18.15	37.74
NCCZ+BOD	NCCZ = 159.06 BOD = 108.9	63.43	NCCZ = 22.37 BOD = 24.23	42.80
NCCZ+CRBC	NCCZ = 159.06 CRBC = 248.62	30.41	NCCZ = 22.37 CRBC = 15.35	31.54

The scale inefficiencies are calculated as the absolute value of (1-Seff)*100. Source: Based on author's calculations

5.3 Examination of hypothetical merger cost changes with changing in inputs

The section 5.3 mainly discusses the four of the hypothetical merger cases in Table 11 with values in all years in the period from 2007 to 2013. Hence, cases number 3 FJHX merged NCCZ, case number 5 BOD merged FJHX, case number 8 NCCZ was merged by HKB and case number 9 NCCZ was merged by BOD in 2007 was the hypothetical mergers we use to make more in depth analysis. The analysis above is based on the historical literatures studied on the banks' mergers, and they are more relied on the static accounting information. However, in reality, when merger happens, the inputs and outputs value changed according to the performance of the merger. Specially, when the bidding bank takeover the target bank, every management detail in these two banks will become one, such as, the two banks' management strategy can only survive one and the only one series of regulation exist after the merger. After the merger happens, the first years this new bank may have the cost increase due to it needs time to reduce its double management team and rules and internal redundancy. In this paper, we hypothetically assume that its inputs will increase 10% per year and lasts for three years after the year merged. And then, when the new bank finishes its internal restructuring, the benefit of the merger may be able to see from its report, which means it will be more efficiency than the pre-merger bank using fewer inputs to make the equivalent outputs.

Hence, based on different performance level, we add three new models (see Table 12). First one is the bank performed neutral, that although it has raised 10% inputs in first three years after merger, it has no inputs changes since then. The second model assumed the bank has good performance on this merger that it started to reduce the usage of its inputs since 2010 at 5% per year. And then, the final model makes the

assumption that the hypothetical merger bank has excellent performance with 10% inputs decrease from the fourth year 2010 to 2013. In these three models, we want to test their cost efficiencies under different level of inputs which may be the actual situations occurred in reality.

Therefore, we can make our hypothesis as:

Hypothesis 1: *In the first three years after Chinese commercial bank hypothetical mergers, three models have the same cost efficiency degree or almost the same.*

Hypothesis 2: *In the next four years from 2010 to 2013, Chinese commercial bank hypothetical mergers have different cost efficiencies in different models, and the more inputs they saved, the more cost efficiency they have. Therefore, the better cost savings the banks can have in the end.*

Table 12 The Input Changing Percentage (%)

	2007	2008	2009	2010	2011	2012	2013
Neutral	10%	10%	10%	0%	0%	0%	0%
Good	10%	10%	10%	-5%	-5%	-5%	-5%
Excellent	10%	10%	10%	-10%	-10%	-10%	-10%

Sources: based on author's hypothesis

Case 3 FJHX+NCCZ

Table 13 Cost Savings (USD thousands) of three inputs changing models for individual hypothetical merger

FJHX+NCCZ	2007	2008	2009	2010	2011	2012	2013	2006-2013
Neutral	119,178	13,825	99,072	-23,172	-255,484	-647,643	131,597	-562,625
Good	119,396	12,638	98,924	-23,213	-255,550	-647,541	131,794	-563,552
Excellent	119,348	13,912	99,011	-22,949	-256,082	-647,045	134,692	-559,113

Source: Based on author's calculations

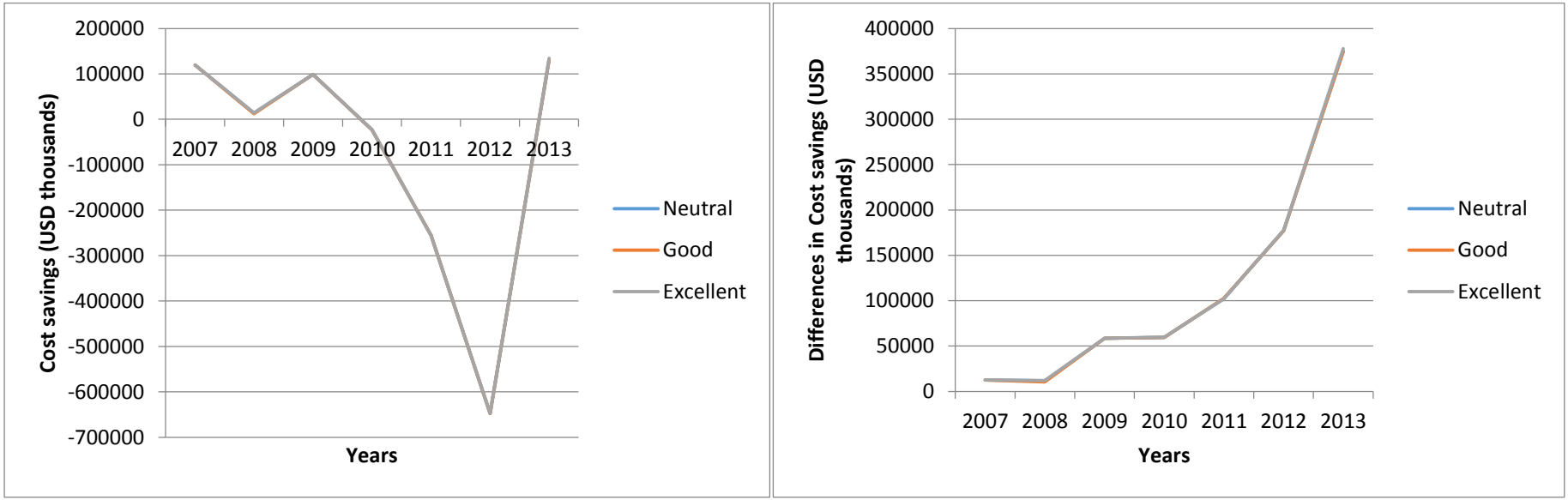


Figure 4 the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances and their differences

(Left) the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances; (Right) the differences of cost savings of new models and original hypothetical merger bank cost savings in Table 11 (Neutral – original; Good – original; Excellent – original).

In the case 3 that FJHX merges NCCZ, hence, for the new bank FJHX+ NCCZ can expand its operational scope from a single province in Fujian or Jiangxi to both. Hence, this should be a good hypothetical merger that its trans-regional business increases its branches and potential clients and also increases its total assets with higher level of scale efficiencies.

The original total cost savings it has hypothetically from 2007 to 2013 is US $1,359 million. With the changing in inputs, the cost savings dramatically drop to around US $560 million in these three new models. However, the differences between these three models are small compare to their overall costs. In the neutral model, that with 0% inputs increase or decrease from 2010 to 2013, the bank has US 562.625 million cost savings in total. For each year, the trend is not smooth, mainly affected by the FJHX bank scale efficiency, in table 10, we can say that from 2007 to 2012, the trend of this figure is similar to original case 3. However, without continuous the trend of cost saving, it is interesting to see that at the last year, it turns to become cost increasing instead with US $131.597 million. This may be caused by the circumstances that at 2013, scale efficiencies of FJHX and NCCZ equals to 0.9933 and 0.734, the different results of them make it increases rapidly from 2012 cost savings to 2013 cost rising. In addition, according to the accounting information of NCCZ, this bank has serious high level of non-performing loans in 2012 and lack of annual report in 2013 (on its official website), makes its effect much higher than FJHX, that may be the reason of the figure 4 has a suddenly increasing costs in 2013. In the good model, hypothetical merged bank FJHX+ NCCZ also has its inputs increased by 10% but 5% decrease since the fourth year from 2010 to 2013. The results of its seem not to be differ from neutral model significantly, but look at Figure

4 Right, this merged bank has a continuously increase on differences in cost savings in the period from 2007 to 2013.

For this bank, the first three years' cost savings are significant that when its costs increased 10% in 2007- 2009, due to huge costs of reorganization, its cost savings dropped almost 58.79%, and when its inputs changes in the next four years with different level of inputs costs: 0%, -5%, and -10%, its total cost savings does not seem to be significant changed. Hence, from this table we can say that, in order to have a more efficiency merger, hypothetical bank FJHX+ NCCZ should focus on minimizing its reorganizing period's huge costs.

Case 5 BOD+FJHX

Table 14 Cost Savings (USD thousands) of three inputs changing models for individual hypothetical merger

BOD+FJHX	2007	2008	2009	2010	2011	2012	2013	2006-2013
Neutral	151,013	25,153	-97,279	-92,404	-104,354	-72,955	-80,494	-271,319
Good	151,026	25,162	-97,336	-91,316	-101,084	-68,799	-76,799	-259,147
Excellent	151,019	25,173	-97,422	-90,109	-97,539	-64,274	-72,730	-245,884

Source: Based on author's calculations

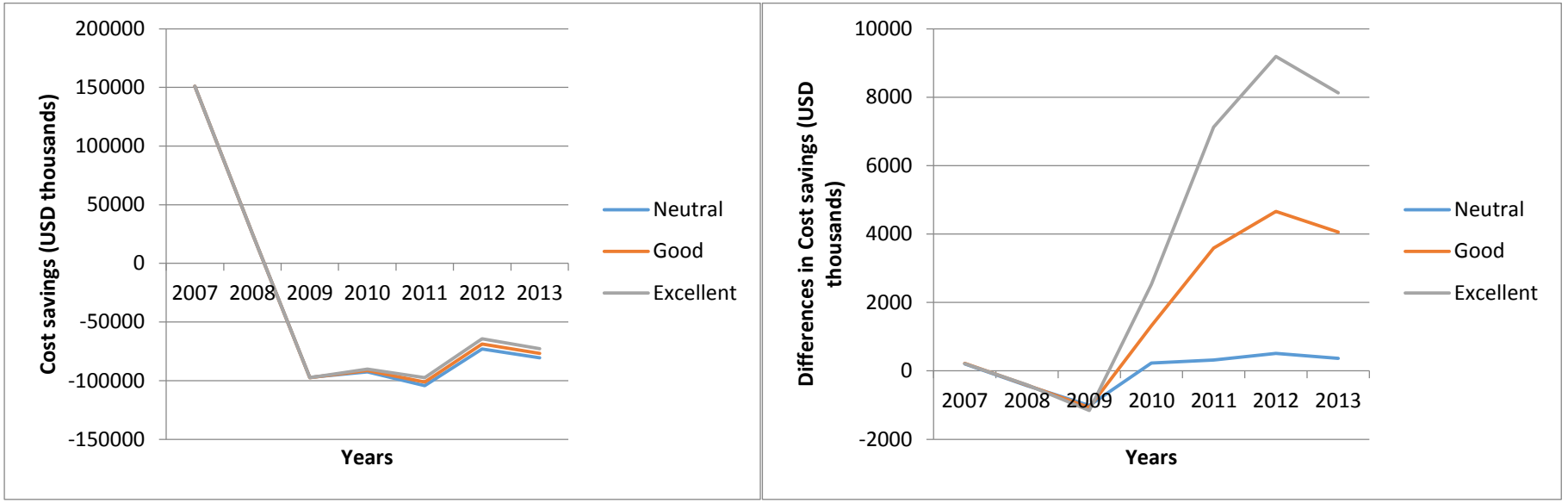


Figure 5 the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances and their differences

(Left) the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances; (Right) the differences of cost savings of new models and original hypothetical merger bank cost savings in Table 11 (Neutral – original; Good – original; Excellent – original)

On this second case of number 5 hypothetical bank BOD+FJHX, the circumstances seem to be different from the first one. Bank of Dongguan (BOD) in Guangzhou province hypothetically merged Fujian Haixia Bank Co. Ltd (FJHX) in Fujian province. This merger has the synergy effect that their business scope is same, with larger economies of scale, the better efficiencies the banks can have. From year 2007 to 2009, all three models have 10% inputs increase as the cost for reorganization. Figure 5 the left one indeed support that and with post-merger time go, the cost expenses decrease and finally in 2009 the merger started to have cost savings for the bank. After year 2010, the hypothetical merger of BOD+FJHX has a relatively stable cost saving annually around US $100 million. Additionally, look at the Figure 5 the right one to see the comparison among inputs changing models. Oddly, it does not fit the hypothesis we made that the more inputs they saved, the more costs they can reduce. Instead, the positive gap between “Excellent” cost savings and the original one in Table 11 indicates that when inputs reduce 10% since year four, the banks’ cannot reduce cost as much as the one without inputs changed. Additionally, the “Good” model performs less badly compare to the “Excellent” but worse than the “Neutral” one.

This situation may be caused by the low x-efficiencies and diseconomies of scale. According to the Table 17, the x-efficiencies of bank BOD+FJHX in the years from 2010 to 2013 are even lower than that in 2006 to 2009. Therefore, their x-inefficiency is higher and waste more costs on that. Especially the excellent model, its x-inefficiencies are the highest value 29.08% (see Table 17 c) in 2011. Additionally, the bank BOD+FJHX has diseconomies of scale after 2010 under all three models with their scale efficiencies higher than 1. For example, the good model of bank

BOD+FJHX decreasing 5% inputs since 2010, has its scale efficiencies from 1.0093 in 2010 to 1.0916 in 2011, 1.0959 in 2012 and 1.0951 in 2013. The higher value of this above 1, the higher reduced return to scale it has.

Only considering its x-inefficiencies and compare it to the pre-merger bank FJHX and BOD individually, the x-efficiencies in the year from 2007 to 2009 has been increased significantly but that has decreased rapidly (typically in the Excellent Model) from 2010 to 2013. When only considering its scale efficiencies and compare it with pre-merger ones, the scale efficiencies actually increased. The merged bank moved to right on the inverted U-shape cost curve with larger assets and higher value of economies of scale. However, when analysing the combination effect of high x-inefficiencies and diseconomies of scale, this bank has poor performance on these three models with their outcomes are very similar and not able to prove the hypothesis (Section 5.3).

Case 8 NCCZ+HKB

Table 15 Cost Savings (USD thousands) of three inputs changing models for individual hypothetical merger

NCCZ+HKB	2007	2008	2009	2010	2011	2012	2013	2006-2013
Neutral	111,481	18,620	-70,138	-127,790	-299,888	-598,911	-130,725	-1,097,351
Good	111,498	18,629	-69,982	-127,106	-301,344	-602,112	-134,573	-1,104,991
Excellent	111,474	18,607	-69,824	-126,298	-302,915	-605,515	-138,586	-1,113,057

Source: Based on author's calculations

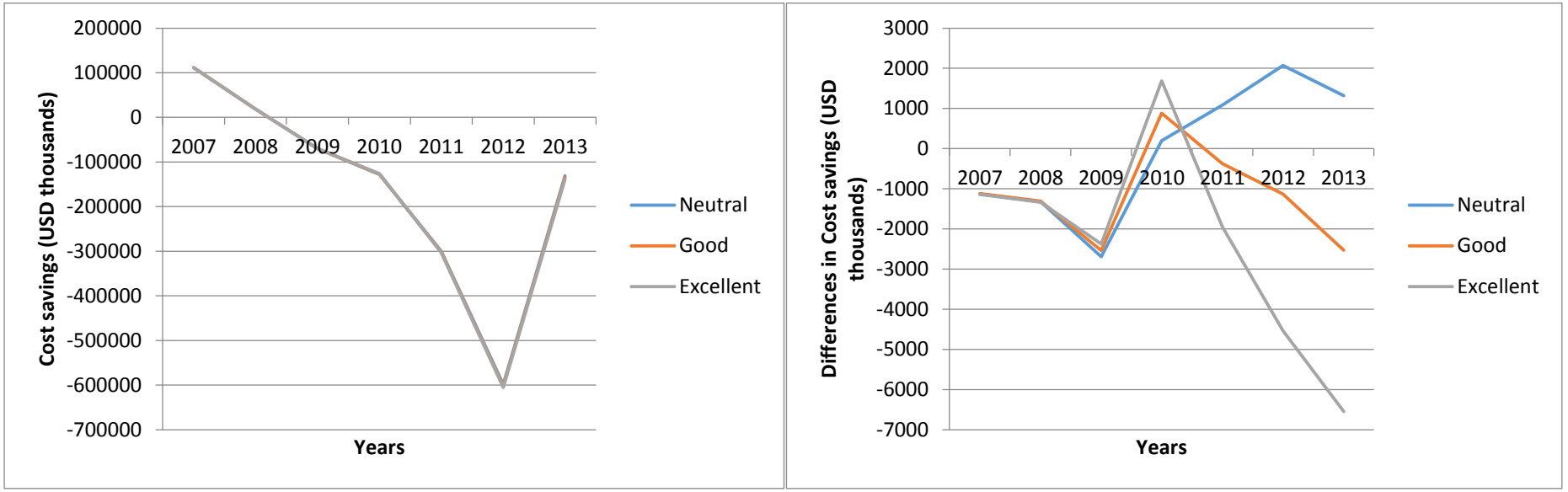


Figure 6 the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances and their differences

(Left) the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances; (Right) the differences of cost savings of new models and original hypothetical merger bank cost savings in Table 11 (Neutral – original; Good – original; Excellent – original)

In the case 8 the hypothetical merged bank, NCCZ+HKB, has the similar performance when looking at the Figure 6 (left). This bank is the second best performed bank with its cost savings originally about USD $1,096.871 million. Therefore, generally speaking from the Table 15, we can say that this bank has proven the hypothesis, that the Neutral Model of it (USD $1,097.351 million) performed better than the original one and its Good Model (USD $1,104.991 million) has more cost savings than Neutral but the Excellent model is the best with USD $1,113.057 million. However, due to the reduction amount are relatively small compare to each other, hence, it is hard to see the difference from Figure 6 left, therefore, we use the right one to analyse it in detail.

First, according to the lines in Figure 6 left, the cost savings in year 2007 to 2009 are smoothly increase from negative to positive[5]. And after 2010, the cost savings are more rapidly until 2012 and 2013 Bank NCCZ+HKB has a sudden cost increase for all three models. This should be analysed based on the individual model's x-efficiency results and scale efficiency results in Table 17 and 18. From Table 17, we can see that the x-efficiencies of bank NCCZ+HKB in 2007 – 2009 are around 0.95. it means that this bank's performance is close to the best-practice bank in the market with 5% cost waste. However, a dramatically drop of x-efficiencies in year 2010 to 0.7436 with cost inefficiency rate over 25.64% should show its less well-performed cost reduction, the figure shows the opposite. After that, the cost inefficiencies gradually go down back to around 4.9% and then its cost savings amount in 2013 become closely to the value of that in 2010.

[5] However, it is the opposite in the figure lines that cost savings are negative and cost wasting are positive. We analyse cost savings from negative to positive is based on the perspective of savings.

On the other hand, considering scale efficiencies of this bank, although it is differ from that in bank BOD+FJHX who has diseconomies of scale in years between 2010 and 2013, it has diseconomies of scale in years between 2006 and 2009. And after that the bank turns to have economies of scale.

Based on the right part of Figure 6, the differences in cost savings in three models shows the entire opposite results before and after 2010. Before 2010, the Excellent Model has the smallest cost saving amount, especially in 2010 its value equals to USD $126.298 million much smaller than USD $ 127.106 million in Good Model and USD $ 127.79 million in Neutral Model. And after 2010, Excellent Model has the best performance with USD $138.586 million cost reduction in 2013, approximately USD $ 4million larger than Good Model and $8 million larger than Neutral Model. The reason for such phenomena may be caused by its scale efficiencies that its value is greater than 1 before 2010 and smaller than 1after 2010.

Case 9 NCCZ+BOD

Table 16 Cost Savings (USD thousands) of three inputs changing models for individual hypothetical merger

NCCZ+BOD	2007	2008	2009	2010	2011	2012	2013	2006-2013
Neutral	143,767	105,026	-178,475	-147,621	-42,474	211,127	-258,963	-167,612
Good	143,831	105,038	-178,565	-148,240	-43,018	210,198	-260,261	-171,016
Excellent	143,835	105,027	-178,643	-148,833	-43,577	209,181	-261,929	-174,937

Source: Based on author's calculations

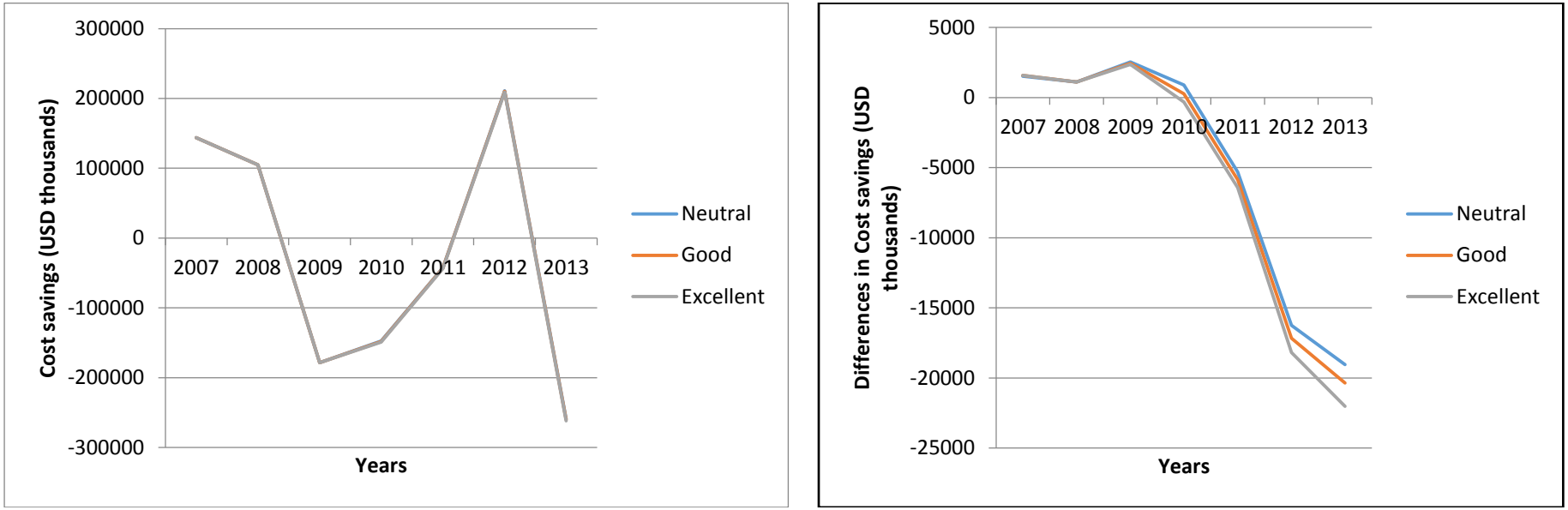


Figure 7 the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances and their differences

(Left) the cost savings of the hypothetical merger bank under neutral, good and excellent circumstances; (Right) the differences of cost savings of new models and original hypothetical merger bank cost savings in Table 11 (Neutral – original; Good – original; Excellent – original)

The last case is case 9 NCCZ+BOD, this hypothetical merged bank has reduced cost USD $133.059 million in total in the year from 2007 to 2013 originally without changing inputs. With the three models in the Table 16, the hypothesis 2 can be proven to be true that the overall cost reduction, Excellent Model is larger than Good Model and Good Model is larger than Neutral Model (USD $167.612 million). This case and case 3 are all include bank NCCZ but the figure they have are almost the complete opposite. Therefore, the reason for their difference should be based on FJHX and BOD. Additionally, the results in case 5 show the hedge effect in the period from 2009 to 2013 of FJHX and BOD but the cost saving of FJHX is larger than the cost increasing of BOD.

From the Figure 7 left part, in order to analyse it, the lines can be divided into three period, 2007-2009, 2009-2012 and 2013. In the first part, although it seems that all three models have similar cost reduction amount and the differences in cost savings, its x-efficiencies and scale efficiencies are very different among three models (see Table 17 &18). For Neutral model, the cost inefficiencies this bank has raised from 1.35% to 10.87% but the other two models have that below 1%. And the trend of its scale efficiencies is not a straight line with its peak value in 2008 at around 0.95. In the next part, its cost increasing with time passed and at the maximum in 2012, however, the results of this cannot be explained by the x-efficiencies and scale efficiencies of bank NCCZ+BOD, because the value of them is not at the turning point or abnormal. Hence, it may be caused by the internal reasons of bank BOD. As far as we know, the CBRC issued Rules for regulating the Capital Adequacy Requirement of Commercial Banks, requires CAR should be 11.5% and 10.5% respectively for main banks and other banks. Bank of Dongguan in Guangdong

province have started its expansion since 2009, However, the fierce competition between other local banks and foreign banks and the new regulations of interest rate liberation in 2013, its performance in 2013 have been dropped rapidly. This figure 7 on the left can be explained based on that the bank of Dongguan (BOD) has focused massively on expansion with high profitability and ignored its cost increasing. Therefore it has a rising up line from 2009 to 2012 but in 2013, the problem of rapid expansion exposed and under the pressure of new regulation, bank started to focus on the internal audit to reduce costs.

Table 17 X-efficiency (part a) and x-inefficiencies (part b) of merger banks with changing in inputs and x-inefficiencies summary (part c)

Part a X-efficiency		2006	2007	2008	2009	2010	2011	2012	2013
	Neutral		0.9916	0.9964	0.9852	0.8022	0.7881	0.9082	0.9795
FJHX+NCCZ:	Good		0.9918	0.9964	0.9854	0.8026	0.7883	0.9081	0.9797
	Excellent		0.9918	0.9965	0.9855	0.8029	0.7882	0.9081	0.9798
	Neutral	0.9583	0.9644	0.9530	0.9552	0.8391	0.8414	0.9405	0.9418
BOD+FJHX	Good	0.9582	0.9644	0.9530	0.9552	0.8402	0.8432	0.9411	0.9424
	Excellent	0.9763	0.9659	0.8995	0.8887	0.7442	0.7092	0.7652	0.7799
	Neutral	0.9542	0.9508	0.9324	0.9528	0.7436	0.7567	0.9283	0.9514
NCCZ+HKB	Good	0.9540	0.9507	0.9321	0.9529	0.7439	0.7559	0.9281	0.9513
	Excellent	0.9537	0.9506	0.9317	0.9529	0.7442	0.7549	0.9279	0.9511
	Neutral	0.9865	0.9684	0.8913	0.8686	0.7208	0.6851	0.7401	0.7663
NCCZ+BOD	Good	0.9956	0.9911	0.9961	0.9830	0.8054	0.8479	0.9509	0.9791
	Excellent	0.9972	0.9941	0.9975	0.9880	0.8112	0.8388	0.9416	0.9830
Part b X-inefficiency		2006	2007	2008	2009	2010	2011	2012	2013
	Neutral		0.84%	0.36%	1.48%	19.78%	21.19%	9.18%	2.05%
FJHX+NCCZ:	Good		0.82%	0.36%	1.46%	19.74%	21.17%	9.19%	2.03%
	Excellent		0.82%	0.35%	1.45%	19.71%	21.18%	9.19%	2.02%
	Neutral	4.17%	3.56%	4.70%	4.48%	16.09%	15.86%	5.95%	5.82%
BOD+FJHX	Good	4.18%	3.56%	4.70%	4.48%	15.98%	15.68%	5.89%	5.76%
	Excellent	2.37%	3.41%	10.05%	11.13%	25.58%	29.08%	23.48%	22.01%
	Neutral	4.58%	4.92%	6.76%	4.72%	25.64%	24.33%	7.17%	4.86%
NCCZ+HKB	Good	4.60%	4.93%	6.79%	4.71%	25.61%	24.41%	7.19%	4.87%
	Excellent	4.63%	4.94%	6.83%	4.71%	25.58%	24.51%	7.21%	4.89%
	Neutral	1.35%	3.16%	10.87%	13.14%	27.92%	31.49%	25.99%	23.37%
NCCZ+BOD	Good	0.44%	0.89%	0.39%	1.70%	19.46%	15.21%	4.91%	2.09%
	Excellent	0.28%	0.59%	0.25%	1.20%	18.88%	16.12%	5.84%	1.70%

Part c X-inefficiencies estimates for three models			
Neutral			
Minimum	0.36%	Maximum	31.49%
Mean	11.19%	Std. deviation	9.30%
Good			
Minimum	0.36%	Maximum	25.61%
Mean	8.13%	Std. deviation	7.51%
Excellent			
Minimum	0.25%	Maximum	29.08%
Mean	10.31%	Std. deviation	9.35%

Source: Based on author's calculations

Table 18 Scale Efficiency of merger banks with changing in inputs

		2006	2007	2008	2009	2010	2011	2012	2013
	Neutral		0.9597	0.8908	0.9500	0.9627	0.9578	0.9705	0.9946
FJHX+NCCZ:	Good		0.9601	0.8911	0.9504	0.9625	0.9578	0.9706	0.9947
	Excellent		0.9595	0.8906	0.9498	0.9629	0.9584	0.9710	0.9951
	Neutral	0.9625	0.9373	0.9381	0.9737	1.0081	1.0904	1.0948	1.0937
BOD+FJHX	Good	0.9622	0.9370	0.9377	0.9735	1.0093	1.0916	1.0959	1.0951
	Excellent	0.9384	0.9228	0.9112	0.9569	0.9905	1.0785	1.0905	1.0877
	Neutral	1.0797	1.0047	1.0192	1.0338	0.9555	0.8988	0.9147	0.9078
NCCZ+HKB	Good	1.0807	1.0054	1.0200	1.0345	0.9581	0.9011	0.9168	0.9100
	Excellent	1.0816	1.0061	1.0207	1.0353	0.9609	0.9034	0.9188	0.9121
	Neutral	0.9482	0.8904	0.9457	0.9005	0.8726	0.9034	0.9022	0.8934
NCCZ+BOD	Good	0.9698	0.9048	0.9654	0.9123	0.8889	0.9139	0.9083	0.8955
	Excellent	0.9595	0.8979	0.9560	0.9066	0.8836	0.9116	0.9081	0.8972

Source: Based on author's calculations

6. Limitations

In the sample we use, there are many Chinese commercial banks lack of valuable accounting information caused by the transparency level of the banking environment, which leads to an unbalance panel data we use in the end. Though unbalance panel data can be used in STATA to have the correct results of x-efficiencies, without the correct disclosure of Chinese commercial banks accounting information, it is hard to say our results are reflecting the true situation of Chinese commercial banks. The consistent trends of hypothetical mergers' cost savings in each year after merger are unable to analyse in this paper.

The hypothetical mergers in this paper are made by two poor scale efficiencies to increase its synergy effect. However, in reality, the bidding banks sometimes have good performance and want to extend its growth, with a high scale efficiency value. In that case, there are over hundreds of combination of mergers among the banks we selected. In the hypothetical merger circumstances, we do not use this over complicated model so that we can have clear and conclusive results without being affected by the good performance of the bidding banks.

The results of efficiencies have unavoidable bias of the methodology we use. STATA sfpanel model to calculate efficiency scores of individual bank has its limitation that it was based on a command which has to be tried manually by changing the starting value of the macro factor or the sequence of technological methods used, to get the results which fit the requirement with gamma in the range and no data missed. Sometimes, there is more than one right command available, and the results may present entire differently when changing the command.

7. Conclusion

Initially we use the cost function implied in Altunbas et al. (1997) and Hadad et al. (2013) to estimates the x-efficiencies and scale efficiencies of the Chinese commercial banks. The results show that Chinese banking system has cost inefficiencies. Its x-efficiencies results indicates that it has poor efficiency level before 2009 but good performance on cost efficiencies after 2009. This may be caused by the new regulation on the requirement of banking sector accounting information disclosure and the adoption of Basel II and III by CBRC. It has economies of scale overall but its industry average scale inefficiencies level also high. To be notice, in Chinese banking sector, the commercial banks cost efficiencies are more determined by the scale inefficiencies (14.38%) rather than x-inefficiencies (7.26%).

Then this paper discusses the ten hypothetical potential mergers' cosy saving results. The total cost reduction of them is US $3.6906 million. Eight of them indeed increase their cost efficiency ratio with massive cost reduction after the mergers in the sample period 2007 to 2013. Only two of them show the opposite with expending more costs than pre-merger. This may be caused by the internal shareholder structure reorganization of the bank from joint Chinese-foreign bank converted to a Chinese-owned commercial bank (e.g. Xiamen International Bank). Therefore, we can say without the particular circumstances, Chinese commercial bank can have cost reduction by using mergers.

After the results in section 5.2 presents the existence of cost reduction, this paper makes a further study on the hypothesis that the Chinese commercial bank

hypothetical mergers have different cost savings when they are facing various inputs decrease ratio. The fewer inputs they use, the more cost improvements they have. However, case 3 and case 5 reject the hypothesis with its neutral model performs better than good model followed by Excellent. However, case 8 and case 9 presents the results that support our hypothesis. The reason of this may be caused by their difference x-efficiencies and scale efficiencies amount through the sample period after merger in 2007 to 2013. Of course, this result, that half of cases support the hypothesis and half of the reject, is inconclusive that our results of Chinese commercial banks with higher inputs reduction percentage can improve their cost efficiencies.

In conclusion, our hypothetical mergers simulate the situation when Chinese commercial banks were merged during the period between 2006 and 2013. It turns out that they can have cost improvements during that period if they mergers with high scale inefficiencies banks and they can also increase their economies of scale. However, we cannot make sure that such improvements can be more efficient with the inputs changes during the after-merger reorganisation period. Because the merged banks also effected by other factors which may influence the results. For example, they are affected by the government policy under different level due to their different nature of commercial banks. What we can conclude is that the various inputs level indeed have an influence on the results of bank merger cost savings.

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