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MASTER'S THESIS

COST EFFICIENCY ANALYSIS OF CHINA'S BANKING SECTOR BASED ON SFA APPROACH

Ljubljana, September 2012   LING HE

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INTRODUCTION

China has become a key player in the world for more than one decade now. It has been enjoying high growth rate since the opening–up economic reform in 1978. Its economic activities have been always financed by bank loans. According to Hansakul (2006), bank loans accounted for 87 % of total funds raised by the Chinese domestic non-financial sector in 2006, up from 76 % in 2001, which indicates the increasingly important role bank loans play to support economic growth. Thus, efficiency of banking sector is determinant whether high economy growth can be maintained.

After entry to the World Trade Organization (WTO) in 2001, China has accelerated reforms so as to adjust to international regulations and rules and at the same time to confront competition arising from more opening-up to foreign banks. A series of reforms regarding structures, ownership and privatization have been carried out to improve efficiency of Chinese domestic banks. In 2006, three state-owned banks went public. In 2010, Agricultural Bank of China was listed on the stock market, which was a milestone in the process of reforms regarding state-owned banks. Meanwhile, joint stock banks and city banks have been continuously pursuing internal reforms to improve financial strength and corporate governance. Some of them have been preparing initial public offering (IPO) and may succeed in the coming five years. Many positive and profound changes have occurred over 2006 to 2011period.

There are very few comprehensive efficiency studies focusing on China's banking sector among substantial efficiency study literature. Additionally, existing studies primarily investigate impacts of reforms carried out in 1990s. Thus, in this paper I focus on post-WTO period from 2006 to 2011 and attempt to provide a relative comprehensive analysis on China's banking sector by employing Stochastic Frontier Analysis (SFA) approach including 35 Chinese commercial banks in the sample. I estimate cost efficiency for individual banks at each period as well as investigate potential correlates to inefficiency.

In terms of methodology, I build two models. Model type (1) is a two-step approach, which relies on a half-normal distribution model proposed by Aigner, Lovell, and Schmidt (1977) in the first stage to estimate cost efficiency scores and run secondary regression of inefficiency with potential correlates. Model type (2) is a single-step approach, which follows Battese and Coelli (1995) specification allowing for simultaneous estimation of cost efficiency scores and potential correlates to inefficiency.

I compare results of these two well-known approaches in order to provide reliable results concerning cost efficiency levels and potential correlates to cost inefficiency which may affect cost efficiency levels.

Main goals of this paper are to examine whether cost efficiency level have been improved during the sample period for the whole banking sector. Then I classify banks into subgroups according to different criteria. I compare cost efficiency among subgroups to find which subgroup is most efficient in this more recent period. According to ownership, banks are grouped into state-owned banks, joint stock banks, and city banks following previous studies focusing on China. With regards to bank size, banks are grouped into small, medium and large banks. Finally, banks are classified into two groups, one take on minority foreign ownership, the other doesn't. Furthermore, I investigate potential correlates such as equity ratio, net interest margin, ROAA, bank size and foreign ownership involvement to cost inefficiency.

Five hypotheses are tested in this paper, which are as follows:

1) I test if cost efficiency levels for the entire banking sector and subgroups are improved over the period of 2006 to 2011. Cost efficiency levels are expected to enhance thanks to reforms.

2) I test which subgroup is most cost efficient among state-owned banks, joint stock banks, and city banks. Existing literature shows that state-owned banks are the least efficient in general, while joint stock banks are most efficient based on earlier sample years and the gap between groups is converging. It makes sense to observe if this finding is still valid after a series of reforms targeted at state-owned banks.

3) I test if bank size is associated with cost inefficiency. Previous studies provide varying evidence in different countries or for certain country in different periods. Thus, I study the relationship between cost inefficiency and bank size.

4) I test if banks with minority foreign ownership are more cost efficient than banks with no foreign ownership. After 2003, foreign ownership was welcomed in partnerships. However, there are limitations on how much shares foreign owners could hold. The ceiling was lifted from 20 % to 25 % in January 2004 for total foreign owned shares, and for single foreign ownership the ceiling was lifted from 15 % to 20 % (CBRC Annual report, 2006). Since foreign ownership must be less than 25 %, I use minority foreign ownership to represent this bank characteristic.

5) I compare estimation results concerning cost efficiency levels, ranking orders, and

relationship between cost inefficiency and potential correlates from two-step and single-step approaches in order to provide relatively reliable results.

The structure of the thesis is as follows. First, I give a short literature review, where I highlight efficiency studies on transitional and developing countries and I also review existing literature on Chinese banking sector. This is followed by introduction to background on Chinese banking sector. I continue the next chapter with methodology and model specification applied in this paper. Next section is describing data and variables. Finally, empirical results for cost frontier functions, cost efficiency levels, potential correlates and comparison of results from two models are presented. The paper concludes with results of five hypotheses.

1 LITERATURE REVIEW ON BANKING EFFICIENCY

Efficiency studies date back to 1950s. A large number of authors dedicate to the development of this subject. As Farrell (1957) states, it is important to know how far a given industry can be expected to increase its output by increasing its efficiency without absorbing further resources. He defines a measure of firm efficiency which could account for multiple inputs. Many researchers attempted to adjust and extend the work of Farrell afterwards. Nowadays, academic papers on efficiency measurement have developed into two main streams of frontier efficiency methodology: parametric and nonparametric. The main differences among them are in the assumptions imposing on the functional form of the frontier, random error, and inefficiency terms. There are four commonly used frontier analysis methods: the Data Envelopment Analysis (DEA) approach, the Stochastic Frontier Analysis (SFA) approach, the Thick Frontier Approach (TFA), and the Distribution-Free Approach (DFA). The nonparametric approach (DEA) employs mathematical programming techniques to obtain relative efficiency scores. Its key limitation is the general assumption that there are no random errors caused by measurement, inaccuracy associated with accounting data and no luck effect (Berger & Humphrey, 1997). In the contrast, the parametric approaches (SFA, TFA, and DFA) are less prone to classify measurement errors or effects of luck as inefficiency, because they allow for random errors. On the other hand, parametric approaches can suffer from bias due to imposing a specific distribution on the unknown pattern of inefficiency (Bauer, Berger, Ferrier, & Humphrey, 1998, pp. 90-93).

In the early stage of efficiency study, the majority of studies tackled the issue of scale and scope economies and focused most on individual countries (Altunbas, Gardener, Molyneux, & Moore, 2001). More recently, cost efficiency and profit efficiency have become prevalent topics in efficiency studies, which are the two main economic concepts of efficiency. Berger, Hasan and Zhou (2009) clearly state that cost and profit efficiency measure how well a financial institution is predicted to perform, relative to a "best-practice" financial institution producing the same output bundle under the same environmental conditions. In other words, efficiency measures how close to the minimum cost or maximum profit a bank is, where the minimum cost or maximum profit are determined by best performers in the sample.

1.1 Literature on Transitional and Developing Countries

Efficiency of financial institutions has been widely studied, particularly on commercial banks. Substantial studies on efficiency exist and there are many new ones emerging every year. In Berger and Humphrey's (1997) survey, 116 out of 130 studies were published between 1992 and 1997, which apply frontier efficiency analysis on the financial institutions in the 20th century. Among them, studies focusing on U.S. financial institutions are the most numerous, which account 66 out of 116 single country studies leaving developed European countries as the second.

Interests arise in transitional and developing countries over recent years, where financial markets and institutional structures are different from those of developed countries. Prior to the transition, most of these countries were command economies, where banking sectors were segmented functionally with a state bank responsible for collecting household deposits through extensive branch network, a state foreign trade bank handling all transactions involving foreign currency, a state agricultural bank extends loans to the agricultural sector, and a state construction bank provided funds to national infrastructure development (Bonin & Wachtel, 1999). The credit allocation was directed by state without considering repayment capacity of borrowers', who were primarily state-owned enterprises. Meanwhile, there was no incentive for profit maximization or cost minimization in operation (Fries & Taci, 2005). Most countries started the transition with a small number of large wholly state-owned banks. In addition, banks with majority government-ownership were dominant in the banking sector by controlling more than half of the total assets of banking sector (Bonin, Hasan, & Wachtel, 2005). China's economy bears many similarities with those of transitional

and developing countries, so experience of reforms in banking sector in transitional and developing countries is likely to give insights into development of China's banking sector. Therefore, I highlight literature studying banking efficiency in these countries.

Relationship between efficiency and ownership type has particularly been one of major research interests in transitional and developing countries. Very significant differences are found, whether an institution is state-owned, private domestic or foreign. The most common findings are that foreign banks are the most efficient or approximately equally efficient to private domestic banks. In addition, state-owned banks are on average the least efficient. But there are variations on all of these studies (Berger *et al.*, 2009).

Kraft and Tirtiroglu (1998) found that state-owned and privatized banks in Croatia have greater cost efficiency levels than newly established private banks between 1994 and 1995. Bhattacharya, Lovell, and Sahay (1997) showed that Indian state-owned banks are more efficient than private domestic banks. Matousek and Taci (2002) find higher efficiency in private banks in the Czech Republic between 1993 and 1998 and no evidence of foreign banks to be more efficient. Isik and Hassan (2003) applying DEA approach find that bank efficiency improves considerably after the financial liberalization over the period of 1981 to 1990 in Turkey and results also indicate that although public banks are more efficient, the efficiency gap between them and their private counterparts are converging in the new environment. Bonin *et al.* (2005) research banking sectors in the transition economies of Central and Southeastern Europe over the period of 1996 to 2000. They find foreign banks to be most efficient, followed by private domestic banks, and then state-owned banks, however, the entry of foreign banks forces the entire banking system to be more efficient. Hasan and Marton (2003) observe similar phenomenon that the entry of foreign banks increases cost efficiency in all kinds of banks, not just those with foreign ownership based on Hungary experience between 1993 and 1997. In addition, banks with foreign involvement are found to be significant more efficient than their domestic counterparts. There is another study of transitional nations that finds foreign banks are more cost efficient, but less profit efficient than both private domestic banks and state-owned banks (Yildirim & Philippatos, 2007). Fries and Taci (2005) find that private banks are more efficient than state-owned banks, but there are differences among private banks; privatized banks with majority foreign ownership are most efficient, followed by newly established domestic or foreign owned private banks, and those with domestic ownership are the least

efficient in their study focusing on 15 post-communist countries from 1994 to 2001.

On the other hand, bank size is also an important factor associated with different level of efficiency. However, the conclusions of relationship between bank efficiency and asset size are contradictory in different studies. Some conclude that large banks are less efficient (Bonin *et al.*, 2005), while some find opposite results (Fries & Taci, 2005).

Other firm specific characteristics have been investigated in existing literature as well, such as equity ratio, net interest margin, intermediation ratio. TC/TA (total costs as a fraction of total assets) and ROAA or ROAE are considered as the standard performance measures and investigated in many literature, either as the dependent variables or as one of the many explanatory variables. As dependent variables, efficiency or efficiency relevant variables are independent variables in the regression (Bonin *et al.*, 2005). Or they are treated as explanatory variables of (in)efficiency in the regression. Contradictory results are found for these three indicators. Intuitively, lower costs mean more profits so that higher cost efficiency is supposed to mean lower costs and higher profitability. Consequently, a negative relationship between cost efficiency and TC/TA and a positive relationship between cost efficiency and profitability would be expected. On the other hand, the "quiet life" assumption suggests that banks with higher profitability tend to relax their control over costs. As a result, the opposite signs would be observed for TC/TA and profitability (Weill, 2004).

1.2 Literature on China's Banking Sector

Banking efficiency study in China started in 1990s, rather late comparing to developed countries. A great many researchers have focused on describing the history and reforms in China's banking sector or merely analyzing case studies, for example Bonin and Huang (2001), and DaCosta and Foo (2002). It is also common to calculate financial ratios based on accounting information of limited number of banks in order to evaluate banks' performance (Guo, 2000), which was once a popular method in western countries as well. Under financial ratio method, the first step is usually to calculate a set of financial ratios based on accounting data pertaining to various aspects of performance. For example, growth rate of earnings or deposits, noninterest expenditures to assets ratio or noninterest expenditures to revenue ratio are used to measure economic performance; capital adequacy ratio and liquidity are calculated as risk measures.

Second step is to simply put observations into groups or aggregate these ratios to obtain a score for each observation. These studies mainly focused on limited number of banks due to restricted access to data. Until now financial ratio method is still in use (Wu & Liu, 2010; Zhang & Chen, 2010).

However, such traditional accounting data based financial ratio method suffers from several drawbacks. DeYoung (1997) argues these easy-to-use ratios can be difficult to interpret. Efficiency of banking firms is a complex phenomenon for which simple analysis can yield misleading conclusions. Simply comparing financial ratios of two different banks is inappropriate unless both banks are nearly identical in terms of product mix, bank size, market conditions, and other characteristics that can affect the banks' expenses. It has also been criticized for not taking into account disparities in exogenous prices of inputs and outputs faced by various financial firms.

Since data have been gradually available for public after entering the 21st century, thanks to the opening-up reforms in China's financial sector and listing of many banks, comprehensive studies focusing on China's banking sector appear. Qian (2003) uses Cobb-Douglas production function to estimate X-inefficiency of eight Chinese banks over the period 1995-2000. The results indicate that little evidence of economies of scale is found; large state-owned banks have lower efficiency compared to small and medium sized joint stock banks; factors having impact on cost efficiency are capital structure, ownership, and the ratio of interest over total operating income.

Liu and Song (2004) employ SFA approach analyzing 14 major commercial banks to measure X-inefficiency from 1996 to 2002 and find similar results that state-owned banks have lower efficiency in comparison with joint stock banks; however, efficiencies of two groups' are converging.

Yao, Feng and Jang (2004) apply SFA approach to estimate production function on 22 commercial banks between 1995 and 2001. Furthermore they investigate the effects of ownership structure and hard budget constraint on efficiency. Profit before tax and loan are used as dependent variable respectively. Their findings indicate that non-state-owned banks are more efficient than state-owned banks; banks facing harder budget tend to perform better than those heavily capitalized by state or provincial government.

Chen, Michael, and Kym (2005) use DEA approach to estimate cost efficiency of 43 banks over the period 1993 to 2000 and study effect of deregulation initiated in 1995. Their finding suggests large banks and small banks are more efficient than medium sized banks; deregulation improves cost efficiency level including both technical and allocative efficiency.

Kumbhakar and Wang (2007) evaluate performance of 14 major Chinese banks during the reform of banking industry from 1993 to 2002 and find whole state-owned banks are less efficient than joint stock banks.

Fu and Heffernan (2006) employ SFA approach with different assumptions of inefficiency term to measure X-efficiency of 14 major Chinese banks find that cost efficiency of joint stock banks are higher than state-owned banks over relative long period of 1985 to 2002.

Berger *et al.* (2009) focus on effects of partial privatization and ownership restructure - taking on minority foreign ownership on efficiency of Chinese banks over 1994-2003 based on SFA approach. Their finding suggests state-owned banks are by far the least efficient while foreign banks are most efficient, and minority foreign ownership is associated with significant improvement in efficiency.

A more recent paper employs SFA approach to analyze 14 major Chinese commercial banks over 1993 to 2006 (Peng, 2007). The findings include: most of banks have no evidence of economies or diseconomies of scales; generally banks experience improvement in efficiency; and non-state-owned banks are more cost efficient and cost efficiencies of different groups are converging.

Few authors attempt to compare efficiencies of China's banks with banks in other countries. One study does comparison by including three German banks with eight Chinese counterparts into the sample to estimate a common cost frontier over the period of 1998-2005. It concludes that Chinese banks are less efficient in general but are catching up at an increasing rate. The most surprising result is that one Chinese domestic bank, Bank of Communication, is the most efficient bank among entire sample (Liu & Li, 2006), which may result from small sample size or lack of consideration of certain crucial factors.

Most of these studies focus on 14 major commercial banks in China. The number is small. In addition, majority of them only examine efficiency levels of subgroups categorized by ownership and believe that state-owned banks are least efficient in China, while joint stock banks have higher efficiency. When foreign banks are included, foreign banks are the most efficient and foreign involvement has positive influence on efficiency level. A few investigate potential correlates like capital structure, the ratio of interest over total operating income, and hard budget constraint (Qian, 2003; Yao *et al.*, 2004).

2 BACKGROUND ON CHINA'S BANKING SECTOR

The chapter outlines the history, regulation and economic environment of the China's banking sector, which is intended to provide a background for those who are not familiar with it. China's banking sector has undergone a dramatic change during the development of modern China. Since 1978, reforms have been taking place in the banking sector all the time aiming at transforming banking sector from policy-driven into market-oriented and enhance efficiency. History is divided into three periods: prior to the 1990s, during the 1990s until WTO entry in 2001, and after WTO entry.

2.1 Pre-1990s Banking Environment

In 1940s, the centrally planned banking system was formed following the system of the former Soviet Union. In 1948, the People's bank of China (PBOC) was established which combined the roles of central and commercial bank. China's banking system had remained a mono-bank system till the economic reform in 1978. All banks were part of the administrative hierarchy, either restructured into the PBOC system, or under administration of the Ministry of Finance (MOF). The entire banking sector was regulated by strict cash and credit plans to ensure that national production plans would be fulfilled (Berger *et al.,* 2009, pp. 4-6).

For ideological reasons no stocks or bonds were issued by central government. When Mao's reign ended in 1976, the new government unwillingly promoted new securities markets. The post-Mao leadership initiated economic reforms in 1978. Economic reforms consisted of four major components: decentralization of economic administration; partial adoption of market mechanisms; wider use of economic means

(such as taxes, credit, interest rates, and price mechanisms) instead of administrative commands in economic management; and partial liberalization of private business activities. As an integral part of the economic reforms, the organizational and functional reforms of the banking system were put into effect (Imai, 1985, p. 460). In line with opening-up economic reform in 1978, banking sector welcomed a series of changes. One of the biggest reforms occurred in 1984, when a mono-bank system was replaced by a multi-tiered one. Central banking functions were separated from the rest (Herrero-Garcia, Gavila, & Santabarbara, 2006, p. 311). First, Bank of China (BOC), China Construction Bank (CCB), Agriculture Bank of China (ABC), and Industry and Commercial Bank of China (ICBC) which formed the so called the Big Four whole state-owned specialized banks, were split from PBOC. PBOC formally became central bank of China, while the Big Four served as fiscal budget distributors which extended loans to the state-owned enterprises (SOEs). Initially, SOEs' losses were financed from the national treasury, which relied heavily on bond financing. As the fiscal deficit grew, the central government forced the SOEs to meet their financial requirements with bank loans. The SOEs considered this bank debt as working capital that businesses losses and defaults were dealt with by additional borrowing (Dobson & Kashyap, 2006, pp. 105-106). In addition, each of the Big Four was limited to serve only designated sectors of the economy initially. BOC was designated to foreign trade and exchange; the CCB took charge of funding primary construction projects; the ABC focused on taking deposits in rural areas and extending loans to agricultural production; and the ICBC was responsible to fund commercial and industrial activities in urban areas.

Then, in 1985, the Big Four were allowed to serve all sectors instead of only designated ones. For deposit business their customers could be both household and corporate. However, their loan customer remained mainly SOEs. Also, they were allowed to expand their business scopes into trust, securities and insurance through affiliates. Almost all banks were well diversified and banking sector entered a universal banking era. Although the government deregulated the financial sector trying to promote competition, it didn't turn out to be intensified at all. To further promote competition, Chinese government permitted certain small and medium sized commercial bank establishments since 1985. This group included Shenzhen Development Bank, Guangdong Development Bank, China Merchants Bank, CITIC Industrial Bank, Bank of Communications (which was reestablished after 38 years of inactivity), China Everbright Bank and Hua Xia Bank (Fu & Heffernan, 2006). They started offering

banking services in small regions and latter expanded to nation-wide operation (Berger *et al.,* 2009, pp. 6-11). These banks are categorized into the joint stock banks group in this paper except of the Bank of Communications.

2.2 During the 1990s till WTO Entry in 2001

The increasing need for capital resources became evident with the development of Chinese economy. Government determined to transform command banking sector into market-oriented one. The Big Four which absolutely dominated banking sector mainly served for policy lending and lacked incentive to compete. Small and medium sized commercial banks have incentive to compete and expand markets share. They targeted at private sectors but altogether they only accounted for minor market share measured by assets size. On the other hand, it was very difficult for private sectors to get capital access (Berger *et al*., 2009, p. 5). In 1994, policy lending banks were established so as to take over state-owned banks' projects for development purposes, therefore to promote commercial governance. A new Commercial Banking Law was approved in 1995 to regulate commercial banks and a Central Bank Law of China confirmed PBOC as the central bank and the substantially reduced the influence of governments on credit allocation decisions (Herrero-Garcia *et al*., 2006, pp. 312-314).

Historically, SOEs were not profit-driven but played social roles in the economy by taking responsibilities of maintaining urban employment, providing social insurance and welfare, pensions, medical care, housing and education (Kumbhakar & Wang, 2007). Many SOEs had bad business performances. They were under little budget pressure and could operate under the assumption that their losses would be tolerated (Dobson & Kashyap, 2006, pp. 119-124). When making loan decisions to SOEs, the Big Four did not take into consideration borrower's credibility or profitability of projects. Up until 1996 bank law, loan officers were rewarded on the basis of the volume of loans without sufficient attention to risk. After 1996 lending officers and senior management was responsible for new bad loans (Hawkins & Turner, 1999). Since the beginning of industrial reform in 1984, the number of loss-making SOEs increased dramatically and their performance further worsened after entering the 1990s. These lead to an enormous amount of NPLs accumulated in the Big Four. The PBOC estimates that at the end of 1997, around 20-25 % of total bank loans, or about CNY1,500 billion (USD180 billion), were non-performing, equivalent to just under 20 % of GDP. About 6-7 % of the total NPLs, or CNY400 billion (USD50 billion), were deemed irrecoverable (OECD, 1998).

Chinese government realized the severe situation and wanted a profound reform. In 1998, PBOC reduced local government influence on banking lending activities by replacing 30 provincial branches with nine cross-province regional branches (Berger *et. al.*, 2009, pp.5-6). Provincial governments no longer maintained authority over bank personnel within their localities. In the past, the decisions pertaining to credit allocation was influenced by local governments. Banks were made to lend generously to support ambitious projects of local governments in a race to outgrow neighboring cities and provinces.

Reforms in banking sector wouldn't succeed unless SOEs took part in reform in order to get rid of problems at the root. In the interest of social stability, banks largely bore up the reform cost of the SOEs. For example, by the end of 2000, 51.2 % of the 62,000 firms that had completed their change of ownership failed to repay bank loans. Since a large number of insolvent SOEs were closed down, some loans were written off (OECD, 2002).

In the light of reforms, MOF set up four asset management companies (AMCs) in 1999, one for each wholly state-owned bank to deal with NPLs which accumulated to an enormous number. Thus Cinda (for China Construction Bank), Huarong (for Industrial and Commercial Bank of China), China Orient (for Bank of China) and Great Wall (for Agricultural Bank of China) came into being. AMCs are legally independent agencies collecting NLP's, restructuring them or converting them into equity.

2.3 After 2001 December WTO Entry

China's banking system has continuously undergone significant reforms after entry to the WTO, aiming to modify itself to the WTO rules and also to improve its efficiency to embrace the competition arising from more opening-up to foreign banks. After 2003, foreign ownerships were welcomed into partnership, which not only brought additional sources of capital but more importantly it helped Chinese banks in enhancing their efficiencies and competitiveness by bringing knowledge of corporate governance, production knowledge and innovation. There are limitations on how many shares foreign owners could hold, but the ceiling was lifted from 20 % to 25 % in January 2004 and for single foreign ownership the ceiling was lifted from 15 % to 20 % (CBRC Annual report, 2006).

In 2003, the CBRC was set up to monitor banking sector. It helped China's banking sector make tremendous progress according to Basel rules. The CBRC has been successful in encouraging almost all Chinese banks to adopt a 5-category loan classification system (as opposed to the previous payment-overdue system). The CBRC has set up banks' reporting requirements with special focus on timely monitoring of asset quality (Berger *et al.*, 2009, pp. 6-12). Since the establishment of CBRC there were several improvements, which can be split up into asset quality, capital adequacy and general supervisory matters (Berger *et al.,* 2009; Herrero-Garcia *et al.*, 2006). The five-tier loan classification system and full provisioning of the NPL's was made compulsory for all the banks by the end of 2005 in asset quality. New tools were adopted to strengthen the monitoring of banks' NPLs by making peer group comparison, estimating the deviation of the accuracy of loan classifications and also following the movement of loans of different categories. On capital adequacy, after an evaluation of the compliance with the Basel Core Principles for Effective Banking Supervision, the 8 % minimum CAR, defined in Basel I terms was introduced (Herrero-Garcia *et al.*, 2006, p. 321). By the end of 2003, the overall weighted average CAR of China's commercial banks was -2.98 %. The ratio turned positive in 2004, rose to 4.91 % in 2005, and further jumped to 12.2 % at the end of 2010. Despite the rapid increase of credit supply in response to the global financial crisis and more strict requirements on the quality of capital in the past two years, the CAR of commercial banks has been well maintained at the 2008 year-end level. The number of banks meeting minimum CAR requirements was only eight in 2003, whose combined assets accounted for only 0.6 % of the total. In comparison, all commercial banks have met the minimum requirement at the end of 2010. In the meantime, the leverage ratio of commercial banks remains at the safe level by global standards (CRBC Annual report, 2010, p. 30). Under general supervisory, transparency of banking was further boosted. As required by the CBRC, banking institutions disclose their annual reports which contain the audited financial statements bearing auditor opinions, corporate governance structure, capital adequacy, risk exposures, risk management strategies and practices, and other material quantitative and qualitative information. In addition, the listed banks are subject to more strict information disclosure requirements issued by the China's Securities Regulatory Commission (CSRC). The CBRC regularly communicates with external auditors and banks' Board and management to ensure the reliability of banks' financial data and accounting practices (CRBC Annual report, 2010, p. 31). In the matter of after-tax profit generated by banking institutions grew from CNY61.6 billion in 2002 to CNY253.3

billion in 2005 and further to CNY899.1 billion in 2010. The return on average assets (ROAA) and return on average equity (ROAE) of commercial banks rose from 0.1 % and 3.0 % in 2003 to 0.7 % and 15.6 % in 2005, and further recorded 1.03 % and 17.5 % as of end of 2010 (CRBC Annual report, 2010).

Large commercial banks' market share measured by assets continue to decline, taken up by various types of banking institutions with the effort of government and CRBC continued to push forward reforms of transformation into a market-based economy. And in terms of diversification in market share effort, they wanted to provide multi-layered funding support for the national economy. Through their nation-wide network, the Big Four banks dominate largest share of retail deposits, provide 80 % of payment services, and extend 56 % of loans out of all financial institutions in 2006 (Hansakul, 2006). Small and medium sized banks mainly compete for corporate deposits.

Currently, China does not have an official deposit insurance scheme. However, there is an implicit deposit insurance scheme for small depositors. A joint document by the PBOC, CBRC, MOF and CSRC issued in 2004 a Directive on Paying Retail Liabilities and Client's Founds in Security Transactions, which states that the government guarantees 100 % for amounts of up to CNY100,000 in individual banks accounts. The guarantee covers only natural persons, but not legal entities i.e. corporate (Hansakul, 2006).

After entry to the WTO, the Big Four experienced major structural reforms. These reforms are mainly aimed at promoting a commercial-driven business culture and to enhance their efficiency. The reform comprises four main steps: recapitalization, reform of internal structure, strategic partnership and stock market listing. The recapitalization started in December 2003 with a capital injection of USD22.5 billion into BOC and the same amount to CCB by the central bank PBOC. PBOC transferred the funds from its international reserves to the Central Huijin Investment Company (Central Huijin) which is a wholly state-owned. Central Huijin was established in 2003 and acts as the holding company for the government's shares in BOC and CCB. In April 2005, another injection went to ICBC through Central Huijin for a sum of USD15 billion. Eventually, the recapitalization finished in November 2007 with another capital injection of USD19 billion to ABC. Central Huijin plays the same role in the process.

In July 2010, the ABC was successfully listed on the A-share and H-share markets, raising USD22.1 billion. By then, all the Big Four banks have changed from a wholly state-owned bank structure to a diversified shareholding one, although Chinese government remains the largest shareholder. It marks that major reforms regarding structures and ownership of state-owned banks come to an end. Meanwhile, joint stock banks and city banks have been continuously pursuing internal reforms to improve financial strength, corporate governance, and some have been preparing IPO for several years and will be listed in stock market in near future.

3 METHODOLOGY AND MODEL SPECIFICATION

3.1 The Choice of a Model

As discussed in the literature review part, there are four commonly used frontier analysis methods: the Data Envelopment Analysis (DEA) approach, the Stochastic Frontier Analysis approach (SFA), the Thick Frontier Approach (TFA), and the Distribution-Free Approach (DFA). These approaches differ primarily in the assumptions imposed on the function form of the frontier, random error and inefficiency term. Nonparametric approach (DEA) imposes less restricted assumption but known for neglecting random errors, which are usually caused by good or bad luck and measurement error. According to Mountain and Thomas (1999), banking sector is prone to suffer from measurement error caused by using accounting information for prices of input. Thus, parametric approaches (SFA, TFA, and DFA) are more appropriate for banking efficiency study.

China's banking sector has undergone significant reforms all the time since 1978. It is more useful to estimate efficiency scores for individual bank at each period of time. Therefore, TFA and DFA are not appropriate for this paper studying efficiency of China's banking sector, as DFA only generates estimates of overall cost efficiency for entire sample period while TFA estimates cost efficiency only for groups of banks. SFA is applied in the paper since it meets such requirement, although been criticized for imposing a specific distribution on the unknown patterns of inefficiency terms.

SFA is proposed by Aigner *et al.* (1977) and Meeusen and van den Broeck (1977) independently. The original specification involves a production function specified for cross-sectional data which has an error term composed by two components. One is to

account for random effects and the other to account for technical inefficiency. Aigner *et al.* (1977) assume that random error has normal distribution, whereas inefficiency term has non-negative half-normal distribution. Many extensions and adjustments have been developed to the original SFA model after it proposed. For example, Stevenson (1980) specified inefficiency to be truncated-normal which is less restrictive; Pitt and Lee (1981) and Schmidt and Sickles (1984) extend it to accommodate panel data; Greene (1990) specified inefficiency error term to be two-parameter gamma. The logic behind is that the inefficiencies must have a truncated distribution because inefficiencies cannot be negative. Both the inefficiencies and the errors are assumed to be orthogonal to the input, output, or environmental variables specified in the estimating function. The estimated inefficiency is taken as the conditional mean or mode of the distribution of the inefficiency term, given the observation of the composed error term (Berger & Humphrey, 1997).

Two types of efficiency concepts are commonly used to measure efficiency level: profit efficiency and cost efficiency. I choose to measure the latter one in this paper, as it the most commonly specified efficiency in the literature. Cost efficiency measures how well a banking firm is predicted to perform relative to a "best-practice" bank producing the same output bundle under the same environmental conditions (Berger *et al.*, 2009). In other words, cost efficiency measures how close a specific bank is to the minimum cost, where the minimum cost is determined by best performers in the dataset.

The general SFA model can be expressed in the following form (Coelli, Prasada Rao, O'Donnell, & Battese, p. 242):

$$ln\, TC_{it} = c(x_{it}; \beta) + v_{it} + u_{it} \qquad (1)$$

Where TC_{it} denotes observed total costs at the *t*-th observation (*t=1,2,…T*) for the *i*-th firm (*i=1,2,…, N*);

x_{it} is a $(1 \times k)$ vector of output quantities and input prices;

β is a $(k \times 1)$ vector of unknown parameters to be estimated;

$c(\cdot)$ is a suitable function form;

v_{it} is stochastic error capturing the effect of noise and measurement errors which are assumed to be iid. $\mathcal{N}(0, \sigma_v^2)$, and independent of the u_{it};

u_{it} is non-negative inefficiency term.

Aigner *et al.* (1997) assumed that v_{it} has normal distribution and u_{it} has half-normal distribution, which is often called half-normal model. Alternative distributions are proposed later on, for example, Stevenson (1980) specified inefficiencies to be truncated-normal, Greene (1990) specified them to be two-parameter gamma distribution.

Berger and DeYoung (1997) find that specifying the more general truncated normal distribution for inefficiency is more flexible and it yields minor, but statistically significant different results from the special case of the half-normal. Greene (1990) also states the gamma distribution assumption for inefficiencies is more appropriate than half-normal assumption. Berger and Humphrey (1997) argue that it is not proper to presume that most firms are clustered near full efficiency which is the case under half-normal distribution assumption. However, alternative assumptions of inefficiency allowing for flexibility may make it difficult to separate inefficiency from random error in a composed error framework, since the truncated normal and gamma distributions may be close to the symmetric normal distribution assumed for the random error. There's no consensus on which assumption of inefficiency is superior to another.

Although it has been criticized for relatively inflexible, half-normal assumption of inefficiencies is still dominant in existing literature. As Bauer *et al.* (1998) argued, any distributional assumptions simply imposed without basis in fact are quite arbitrary and could lead to significant error in estimating individual firm efficiencies. They state that one positive aspect with SFA is it will rank the efficiencies of the firms in the same order. Which means the ranks of banks will be affected less by different assumptions. So I follow the dominant specification of half-normal model in the paper in Model type (1) and study the ranking order of banks as well.

Measuring the cost efficiency level for individual bank is usually the first step. It's also interesting to investigate what determine the differences in efficiency level. There is no well-established theory to include explanatory variables, so that factors may be

influential to efficiency levels are called potential correlates. To study these potential correlates, two common approaches are used in existing literature body: two-step approach and single-step approach.

Under two-step approach, the first stage involves the estimation of the stochastic frontier function and (in)efficiencies of individual firms, and usually the second stage is a regression of (in)efficiencies and various explanatory variables and a random error, in general ordinary least-squares regression is applied. It is named two-step approach after the concept of single-step approach has been brought up. Many authors adopt the two-stage approach, including Allen and Rai (1996), Berger and Hannan (1998), Bonin *et al.* (2005), and Berger *et al.* (2009). Some authors also use standard profit measure as dependent variable and efficient relevant variables as independent variables in the secondary regression to investigate relationship between efficiencies and profitability (Bonin *et al.*, 2005). However, two-step approach has been criticized for being problematic. For the reason that in the first stage the inefficiency effects are assumed to be independently and identically distributed, which means effects of correlates are ignored; while in the second stage inefficiency terms are assumed to be a function of various firm-specific factors which implies that they are not identically distributed, thus, it violates the assumption made in the first step (Coelli, 1995; Fries & Taci, 2005; Wang & Schmidt, 2002).

Kumbhakar, Ghost, and McGuckin (1991), propose a single-stage approach to solve this inconsistency problem. They make an explicit function of firm-specific factors in the stochastic frontier models, and all parameters are estimated in a single-stage maximum likelihood procedure. Battese and Coelli (1995) extend this single-step approach to accommodate panel data. Estimation of the parameters of the cost function, measures of bank inefficiencies and correlates of bank inefficiency can be obtained at the same time. Fries and Taci (2005), Yao *et al.* (2004) adopt a single-step approach.

In the paper, I build two models: Model type (1) two-step approach model and Model type (2) single-step approach model to measure cost efficiency scores for individual banks and investigate the same sets of potential correlates in the two models. Therefore I can compare results from the two models and try to provide more reliable results. I conduct Spearman rank correlation of two sets of cost efficiencies from these two models, in order to study impact of different specifications on the ranking orders in

addition to differences in cost efficiency levels following Fu and Heffernan (2006).

3.2 Model Specifications

In both models, cost frontier functions of Dobb-Douglas functional form are specified. There are other functional forms applied in the existing literature, Fourier flexible, and translog. I also estimate cost efficiency by employing translog functional form. However, most of the coefficients for interaction terms are not significant. Thus in the paper, Cobb-Douglas form is applied.

3.2.1 Specification for Model type (1)

Aforementioned, Model type (1) is a two-step approach model, which relies on the half-normal distribution model proposed by Aigner *et al.* (1977). In the first stage to estimate cost efficiency scores, then run ordinary least squares (OLS) regression of inefficiency scores with potential correlates which may explain differences in cost efficiencies.

The frontier cost function is specified in the following form (Berger *et al.*, 2009; Coelli *et al.*, 2005, p. 266):

$$In\left(\frac{TC_{it}}{w_{3it}}\right) = a_0 + \sum_{j=1}^{2} a_j \, In\left(\frac{w_{jit}}{w_{3it}}\right) + \sum_{k=1}^{3} \beta_k \, In(y_{kit}) \qquad (2)$$
$$+ year \, dummy_t + v_{it} + u_{it}$$

Where TC_{it} denotes observed total costs at the *t*-th observation (*t = 1, 2,…T*) for the *i*-th bank (*i = 1, 2,…, N*);

y_{kit} (*k* = 1, 2, 3) stands for *k*-th output at the *t*-th observation (*t = 1, 2,…T*) for the *i*-th bank (*i = 1, 2,…, N*);

w_{jit} (*j* = 1, 2, 3) stands for *j*-th input price at the *t*-th observation (*t = 1, 2,…T*) for the *i*-th bank (*i = 1, 2,…, N*);

year dummy$_t$ are year dummies, where *t = 2, 3,…T, t=1* is omitted as base year;

v_{it} is stochastic error capturing the effect of noise and measurement errors which are assumed to be iid. $\mathcal{N}(0, \sigma_v^2)$, and independent of the u_{it};

u_{it} is half-normal non-negative inefficiency term assumed to be iid. $\mathcal{N}^+(0, \sigma_v^2)$.

As shown in equation (2), total cost and input price terms are normalized by the last input pricew_3, in order to impose linear homogeneity on the model. Therefore, the following restriction applies to the parameters of the cost function: $\sum_j a_j = 1$, for all *j*. Year dummies are incorporated following Berger *et al.* (2009) to avoid any estimation biases that may arise due to potential changes in bank performance caused by technological progress or changes in the economic and regulatory environments.

3.2.1 Specification for Model type (2)

In Model type (2), I follow Battese and Coelli (1995) model which allows for the estimation of the cost function and identification of the correlates of bank inefficiencies in a single-step. The estimation allows for bank inefficiencies to have a truncated-normal distribution that is independently but not identically distributed over different banks. The mean of the inefficiency term is a liner function of a set of bank-level variables and environment variables.

The specification of single-step model can be expressed in the following form (Battese & Coelli, 1995; Coelli *et al.*, 2005):

$$In\left(\frac{TC_{it}}{w_{3it}}\right) = a_0 + \sum_{j=1}^{2} a_j In\left(\frac{w_{jit}}{w_{3it}}\right) + \sum_{k=1}^{3} \beta_k In(y_{kit}) \qquad (3)$$
$$+ year\ dummy_t + v_{it} + u_{it}$$

where TC_{it}, y_{kit}, w_{jit}, *year dummy$_t$*, and v_{it} have the same definitions as in Model type (1), but

$$u_{it} = z_{it}\delta + W_{it} \qquad (4)$$

where the random error, W_{it}, is defined by the truncation of the normal distribution with zero mean and variance, σ^2, such that the point of truncation is $-z_{it}\delta$, i.e., $W_{it} \geq -z_{it}\delta$. These assumptions are consistent with u_{it} being a non-negative truncation of the $\mathcal{N}(z_{it}\delta, \sigma^2)$ distribution (Battese & Coelli, 1995).

Inserting the equation for u_{it} in (4) in equation (3) yields:

$$In\left(\frac{TC_{it}}{w_{3it}}\right) = a_0 + \sum_{j=1}^{2} a_j\, In\left(\frac{w_{jit}}{w_{3it}}\right) + \sum_{k=1}^{3} \beta_k\, In(y_{kit}) + year\; dummy_t \qquad (5)$$
$$+v_{it} + z_{it}\delta + W_{it}$$

3.2.3 Cost efficiency measurement

The measure of cost efficiency is the ratio of minimum cost to observed cost, which can be expressed to be (Coelli *et al.*, 2005, p. 267):

$$CE_{it} = \frac{TC_{it}^{F}}{TC_{it}} = exp(-\hat{u}_{it}) \qquad (6)$$

where TC_{it}^{F} is the stochastic frontier or minimum cost of the *i*-th bank in time *t;*

TC_{it} is the observed total cost of *i*-th bank in time *t*;

and $\hat{u}_{it}$ is expected value of inefficiency term for *i*-th banking firm at time *t*.

A cost efficiency score of one indicates a firm is on the frontier, while other banking firms receive scores between zero and one. Alternatively, the cost inefficiency score can be calculated as the reciprocal of the cost efficiency score defined in equation (6).

3.3 Inputs and Outputs Definitions

Banking industry is characterized by multiple inputs and outputs. Economists have used different definitions of input and output. No consensus has been made yet. There are two common approaches to define inputs and outputs for bank institutions in the literature: intermediation approach and production approach.

Intermediation approach developed by Sealey and Lindley (1977) assumes banks function as the intermediary between depositors and investors, and various types of earning assets are treated as outputs while deposits along with capital and labor are used as inputs in the production process.

Under the production approach, financial institutions are viewed as primarily production services for account holders. The financial institutions perform transactions and process documents for customers, such as loans applications, credit reports, checks or other payment instruments, and insurance policy or claim forms. Under this approach, output is best measured by the number and type of transactions or documents processed over a given time period (Berger & Humphrey, 1997). Production approach has been criticized that it fails to carefully analyze both the technical and economic aspects of production at the financial firms (Kumbhakar & Wang, 2007).

In this paper, I follow along the lines of traditional intermediation approach for the definition of inputs and outputs. Borrowed funds, labor, and physical capital are considered as inputs, while loans, securities and other earning assets are treated as three outputs.

4 DATA AND VARIABLES

My sample is an unbalanced panel data set which consists of 35 Chinese banks over the period of 2006-2011 totaling 154 observations. Data are primarily collected from Bankscope, which is published by Bureau van Dyk. I include banks which have at least four years of available data in the Bankscope database over period of 2006 to 2011. The minimum requirement of four years helps to distinguish reliably between random noise and bank inefficiency in the errors of estimated cost functions following Fries and Taci (2005). For missing data and unavailable financial information in Bankscope database, various sources are referred to, such as Annual issues of Almanac of China's Finance and Banking, annual reports of individual banks, reports published by CBRC, websites of individual banks and financial news.

I exclude policy banks and former policy bank China Development Bank (CDB) which finished its transformation into commercial bank only in 2010, as policy banks serve for totally different objectives from other commercial banks. Policy banks and CDB

account for around 8 % assets share of all banking institutions in 2010 (CRBC Annual report 2010, p. 154).

These 35 commercial banks are classified into three groups: state-owned banks (SOBs), joint stock banks (JSBs), and city banks (CBs). State-owned banks group consists of five banks: the Big Four - ICBC, BOA, CCB, and ABC, plus Bank of Communication (BOCOM). They are now referred to as state-owned banks opposed to wholly state-owned banks previously. Because they have undergone remarkable reforms including ownership restructure, they are not wholly owned by state any more. Joint stock banks are either entirely private-owned or jointly owned by private enterprises, local governments and foreign owners. They operate in many cities through large number of branches locating nationally. City banks evolved from urban credit cooperatives and local government remains the largest owners. Their business scope usually concentrates in the city where they locate. During the sample period, some city banks have experienced reforms which involve recapitalization, internal reform, taking strategic investors, and IPOs. They mainly serve the needs of local small and medium sized enterprises which is a key growth sector. Due to their strong ties with local governments, they have stable deposit sources from local governments and corporations (Hansakul, 2006).

Foreign banks are not included in the sample, for the reason that reforms have been primarily targeting at domestic banks. Besides, foreign banks have quite different business scopes and managerial strategies from Chinese domestic commercial banks. They concentrate more on corporate banking areas such as loan syndication for large projects, treasury and private wealth management, as well as investment banking (Hansakul, 2006). In addition, their outputs and input prices are considerably different from other groups.

I have full information for four of the SOBs group over 2004-2011 (ICBC, BOA, CCB, and BOCOM). With ABC, data for years from 2004 to 2005 are missing. SOBs posses almost half of the assets share of all banking institutions in 2010 (CRBC Annual report 2010, p. 154), which were 58 % and 55 % in 2003 and 2006 respectively (CRBC 2006, p. 132).

The sample includes eight joint stock banks out of total 12, which are CITIC Bank,

China Everbright Bank, Huaxia Bank, Guangdong Development Bank, China Merchants Bank, Shanghai Pudong Development Bank, China Minsheng Banking Corporation, China Zheshang Bank. These eight banks account for 80 % of all joint stock banks total assets share, and account for around 10.5 % assets share of all banking institutions in 2010. In addition, I have 22 out of the 114 city banks in China. All city banks in total possess around 8 % assets share of banking institutions in 2010, while these 22 banks included almost posses half the assets of all city banks. The rest of assets are possessed by other banking institutions: rural commercial banks, rural cooperative banks, urban credit cooperatives, rural credit cooperatives, non-bank financial institutions, new-type rural financial institutions and postal saving bank, and foreign banks (or branches). Foreign banks (or branches) account for 0.7 % of total banking institutions' asset in China in 2010. The banks in the sample cover around 64.5 % assets share of all banking institutions in China as the end of 2010 in total.

All financial data (excluding financial ratios) are provided by Bankscope in nominal terms in thousand U.S. dollars converted at exchange rates at the end of each year. Using U.S. dollar as unit is to be more comparable with other existing literature on Chinese banking sector. I test with different units which obtain consistent estimation results of coefficients for cost frontier functions and cost efficiencies.

Banks are also classified according to size, which is defined based on total assets of bank at time t. A specific bank is a small bank if its assets are less than or equal to USD10 billion at time t; a medium bank if the bank's assets are greater than USD10 billion but less than or equal to USD100 billion at time t; a large bank if its assets are greater than USD100 billion at time t. Information of banks taking on minority foreign ownership is collected separately from annual reports of each bank. MFO takes value 1 in the second year of taking on minority foreign ownership, otherwise has value 0. Table 1 shows the distribution of the sample across years, by various ownership groups, by bank size, and by with or without minority foreign ownership.

Table 1. Number of Observations for Full Sample and Subgroups in Different Years

Year	Total	2006	2007	2008	2009	2010	2011
Full sample	154	19	26	33	30	32	14
Observations according to ownership							
State-owned banks (SOBs)	29	4	5	5	5	5	5
Joint stock banks (JSBs)	41	5	6	8	8	8	6
City banks (CBs)	84	10	15	20	17	19	3
Observations according to bank size							
Small banks	46	9	10	11	9	7	2
Medium banks	48	5	8	11	10	12	2
Large banks	60	5	8	11	11	13	12
Observations according to MFO							
Banks taking minority ownership (MFO=1)	70	5	10	14	14	15	12
Banks with no minority ownership (MFO=0)	84	14	16	19	16	17	2

In the models, total costs are the sum of interest expenses, personnel expenses, and other noninterest expenses. Inputs are borrowed funds, labor and physical capital. Outputs are loans, securities, and other earning assets. The price of borrowed funds, w_1, is measured by the ratio of paid interests on total deposits. Since data on the number of employees are not available for most banks over all periods, following previous authors (Altunbas, Evans, & Molyneux, 2001; Yildirim & Philippatos, 2007), the price of labor, w_2, is measured by the ratio of personnel expenses over total assets. The price of physical capital, w_3, is defined as the ratio of other non-interest expenses over fixed assets. Three outputs are proxies for banking services provided. Total loans, y_1, is the total amount of loans. Securities, y_2, is the sum of securities held by banks. Other earning assets, y_3 is total earning assets less loans and securities (see Table 2).

Table 2. Descriptions of Total Cost, Outputs and Input Prices

Variable	Symbol	Name	Description
Dependent Variable	TC	Total cost	Sum of interest expenses, personnel expenses, and other noninterest expenses
Output price	y_1	Total loans	Total loans
	y_2	Securities	Sum of securities
	y_3	Other earning assets	Total earning assets less loans and securities
Input price	w_1	Price of borrowed funds	Interest expense over the total deposits
	w_2	Price of labor	Personnel expense over total assets
	w_3	Price of physical capital	Other non-interest expense over fixed assets

Descriptive statistics of total cost, outputs and input prices are displayed in Table 3 for full sample and subgroups. Total cost and outputs are all measured in millions of U.S. dollars, whereas input prices are in percentage.

As efficiency alone provides limited information, potential correlates which may explain differences in efficiencies are investigated by many authors. For instance, Allen and Rai (1996), Berger and Mester (1997), and Maudos, Pastor, Perez, and Quesada (2002) investigate internationally, while Yao *et al.* (2004), Berger *et al.* (2009), and Xiong and Sun (2009) study on China's banking sector. For cross-country comparison, country-level factors such as market characteristics and individual bank characteristics are included, whereas researches focusing on a single country primarily investigate firm-specific characteristics.

Table 3. Descriptive Statistics of Total Cost, Outputs and Input Prices for Full Sample
and Subgroups

Variable	Obs	Mean	Std.Dev.	CV
Full sample				
Total cost TC (in $ million)	154	7024.53	12253.21	1.74
Total loans y_1 (in $ million)	154	138894.40	247766.80	1.78
Securities y_2 (in $ million)	154	67348.42	134044.00	1.99
Other earning assets y_3 (in $ million)	154	62727.43	114412.50	1.82
Price of borrowed funds w_1 (%)	154	1.82 %	0.63 %	0.34
Price of labor w_2 (%)	154	0.52 %	0.12 %	0.24
Price of physical capital w_3 (%)	154	67.70 %	37.45 %	0.55
State-owned banks (SBOs)				
Total cost TC (in $ million)	29	28897.17	13148.50	0.46
Total loans y_1 (in $ million)	29	573003.40	284013.60	0.50
Securities y_2 (in $ million)	29	309785.20	149288.40	0.48
Other earning assets y_3 (in $ million)	29	249034.50	151923.80	0.61
Price of borrowed funds w_1 (%)	29	1.66 %	0.29 %	0.17
Price of labor w_2 (%)	29	0.55 %	0.10 %	0.19
Price of physical capital w_3 (%)	29	45.24 %	10.66 %	0.24
Joint stock banks (JSBs)				
Total cost TC (in $ million)	41	4999.04	3322.50	0.66
Total loans y_1 (in $ million)	41	98403.07	65034.42	0.66
Securities y_2 (in $ million)	41	24571.49	16712.31	0.68
Other earning assets y_3 (in $ million)	41	51388.71	35407.01	0.69
Price of borrowed funds w_1 (%)	41	2.02 %	0.61 %	0.30
Price of labor w_2 (%)	41	0.54 %	0.10 %	0.18
Price of physical capital w_3 (%)	41	85.14 %	28.53 %	0.34
City banks (CBs)				
Total cost TC (in $ million)	84	461.90	595.26	1.29
Total loans y_1 (in $ million)	84	8787.05	11205.11	1.28
Securities y_2 (in $ million)	84	4529.21	5869.91	1.30
Other earning assets y_3 (in $ million)	84	3941.52	7145.47	1.81
Price of borrowed funds w_1 (%)	84	1.77 %	0.69 %	0.39
Price of labor w_2 (%)	84	0.51 %	0.14 %	0.27
Price of physical capital w_3 (%)	84	66.94 %	42.76 %	0.64

To investigate potential correlates is one of many goals of this paper. I focus on certain individual bank characteristics in previous studies, since this paper merely studies cost efficiency in a single country. In aforementioned studies, bank characteristics such as organizational form, bank size, market share, ownership, equity ratio, cost-to-assets ratio, loan-to-asset ratio, ROAA or ROAE, net interest margin, standard deviation of return on assets, and impaired loans ratio are included. All of these variables are included in trail analyses, but then omitted for reasons of insignificance, or causing no convergence in estimation process. Eventually, I select five firm-specific characteristics in this paper, which are described in Table 4.

Table 4. Description of Potential Correlates

Symbol	Description of variable
ER	Equity ratio in percentage
NIM	Net interest margin: Net interest income over total assets in percentage
ROAA	Return on average assets in percentage
lnTA	Natural log of total assets
MFO	Minority foreign ownership: Dummy variable identifying the ownership of the individual bank (value 1 in the second year if bank taken on foreign ownership, otherwise value 0)

Descriptive statistics for full sample and subgroups are provided in Table 5. For full Sample, assets range from about USD1.6 billion to USD2,456 billion, with an average of over USD278 billion and a coefficient of variation 1.81. Obviously, the banks in the sample are of varying size. Table 5 also reveals that for subgroup of banks categorized by ownership have similar assets scale within groups. Five banks in SOBs group has mean of about USD1,170 billion. JSBs group has average of about USD181 billion, while CBs group has mean of mere USD18 billion.

Regarding other financial characteristics, the average equity ratio (ER), net interest margin (NIM) and ROAA are 5.69 %, 2.84 %, and 1.03 % respectively for full sample. Although the range for each of these is substantial, all these measures have coefficient of variations below one. A comparison of descriptive statistics for subgroup in Table 5 shows that subgroup means of these three ratios are similar. Hence, size is the primary element of heterogeneity for bank characteristics in the sample.

Table 5. Descriptive Statistics of Potential Correlates for Full Sample and Subgroups

Variable	Obs	Mean	Std. Dev.	Min	Max	CV
Full sample						
ER (%)	154	5.69 %	2.47 %	-13.71 %	13.07 %	0.43
NIM (%)	154	2.84 %	0.61 %	1.71 %	6.11 %	0.21
ROAA (%)	154	1.03 %	0.35 %	-0.15 %	3.00 %	0.34
lnTA	154	17.72	2.02	14.28	21.62	0.11
TA (in $ million)	154	278,694.70	504,387.80	1,591.58	2,456,295.00	1.81
State-owned banks (SOBs)						
ER (%)	29	5.33 %	3.75 %	-13.71 %	7.75 %	0.70
NIM (%)	29	2.65 %	0.33 %	2.11 %	3.29 %	0.12
ROAA (%)	29	1.09 %	0.19 %	0.71 %	1.47 %	0.17
lnTA	29	20.74	0.60	19.21	21.62	0.03
TA (in $ million)	29	1,169,989.00	572,789.50	220,200.90	2,456,295.00	0.49
Joint stock banks (JSBs)						
ER (%)	41	4.87 %	1.72 %	-0.03 %	9.80 %	0.35
NIM (%)	41	2.68 %	0.37 %	2.01 %	3.57 %	0.14
ROAA (%)	41	0.86 %	0.32 %	-0.15 %	1.45 %	0.38
lnTA	41	18.71	0.92	15.88	19.91	0.05
TA (in $ million)	41	181,354.30	119,757.00	7,849.47	443,582.80	0.66
City banks (CBs)						
ER (%)	84	6.21 %	2.11 %	1.26 %	13.07 %	0.34
NIM (%)	84	2.98 %	0.73 %	1.71 %	6.11 %	0.25
ROAA (%)	84	1.10 %	0.39 %	0.15 %	3.00 %	0.35
lnTA	84	16.19	0.99	14.28	18.84	0.06
TA (in $ million)	84	18,497.35	24,760.86	1,591.58	151,803.50	1.34

5. EMPIRICAL RESULTS

In this section, I first outline main hypotheses for the paper. Secondly, I discuss parameter estimates for Model type (1) two-step approach and Model type (2) single-step approach. Thirdly, I present analysis of cost efficiency scores. Fourthly, I

discuss potential correlates to cost inefficiencies. Finally, I compare my results with existing literature on China's banking sector.

5.1 Tests of Main Hypotheses

Main hypotheses tested in this paper are presented as follows:

1) I test if cost efficiencies for the entire banking sector are improved over the post-WTO period of 2006 to 2011. During the sample period, the SOBs have undergone profound structural reforms aimed at promoting market-oriented governance. Many joint stock banks and city banks also have devoted to preparing IPO and experienced various internal reforms to adjust themselves according to the central bank's new policy. Cost efficiency levels are expected to enhance for the entire banking sector.

2) I test which subgroup is the most cost efficient among state-owned banks, joint stock banks, and city banks. Existing literature show that state-owned banks are the least efficient in general, while joint stock banks are most efficient based on earlier periods and the gap between groups is converging. It makes sense to observe if this finding is still valid after a series of reforms targeted at state-owned banks.

3) I test if bank size is associated with cost inefficiency. Previous studies provide varying evidence in different countries or for certain country in different periods. Thus, I study the relationship between cost inefficiency and bank size.

4) I test if banks with minority foreign ownership are more cost efficient than banks with no foreign ownership. Existing literature suggests that foreign involvement is positively associated with higher efficiency level (Berger *et al.*, 2009; Hasan & Marton, 2003) Banks taking on minority foreign ownership are expected to be more cost efficient.

5) I compare estimation results concerning cost efficiency levels, ranking orders, and relationship between cost inefficiency and potential correlates from two-step approach and single-step approach in order to provide relatively reliable results.

I measure cost efficiency levels from pooled observations incorporating year dummies following Berger *et al.* (2009), which avoid any estimation biases that may arise due to potential changes in bank performance caused by technological progress or changes in the economic and regulatory environments. I avoid time variables in the secondary regressions in two-step approach Model type (1). Also there's no time variable in the

function of inefficiency term in a single-step approach Model type (2), given the cost efficiency scores are adjusted for sample years in the cost frontier function.

The SFA approach can be applied either in a set of annual cross-section estimations or in a panel estimation. Fries and Taci (2005) use both estimation approaches and conclude that estimated means of cost efficiency levels are not sensitive to estimation approach. I get similar results by analyzing a reduced number of balanced dataset using both methods: pooled observations incorporating year dummies and panel estimation without year dummies.

5.2 Estimation Results of Coefficients for Cost Functions

Table 6 reports two sets of estimation results for Model type (1) and type (2). One specification is a half-normal model and its secondary regression of potential correlates, the other is a single-step approach including potential correlates as a function of inefficiency term. For both models, I estimate Cobb-Douglas cost functions incorporating year dummies with the same outputs and input prices. Year dummy for 2006 is omitted in the cost function, as it is the base year.

The estimation results reveal a number of important characteristics of the cost function of banks and the correlates to inefficiency in China's banking sector. As expected, all coefficients for outputs and input prices are positive and highly significant for both models. The sum of coefficients for three outputs are 0.9830 and 0.9950 respectively for Model type (1) and type (2), both of which are slightly below one indicating that there is presence of slight economies of scale for the average size banks. One percent increase in loans, securities, and other earning assets would lead to less than one percent of increase in total cost for average size banks.

Table 6. Parameters Estimates for Cost Frontier Functions and Potential Correlates

Model	Model type (1)			Model type (2)		
Variables	Coefficient	Std. Dev.	t-ratio	Coefficient	Std. Dev.	t-ratio
b_{Y1}	0.6794***	-0.0216	31.52	0.6152 ***	-0.0268	22.92
b_{Y2}	0.1996***	-0.0144	13.9	0.2266 ***	-0.0129	17.59
b_{Y3}	0.1040***	-0.0147	7.08	0.1487 ***	-0.0225	6.6
b_{w1}	0.7083***	-0.0199	35.63	0.6953 ***	-0.0193	35.96
b_{w2}	0.2457***	-0.0189	13.02	0.2550 ***	-0.0181	14.12
d_{2007}	-0.0059	-0.0221	-0.27	-0.0145	-0.0218	-0.67
d_{2008}	-0.0035	-0.0209	-0.17	-0.0141	-0.0227	-0.62
d_{2009}	0.0237	-0.0214	1.11	0.0151	-0.0239	0.63
d_{2010}	0.0750***	-0.0221	3.38	0.0541 *	-0.0317	1.71
d_{2011}	0.0687**	-0.0286	2.4	0.0541	-0.0371	1.46
Constant	1.6843***	-0.0901	18.69	1.6455 ***	-0.0957	17.19
Potential correlates	Secondary regression			Estimated from single-step estimation		
ER	-0.0068**	-0.0028	-2.41	-0.0178**	-0.009	-1.98
NIM	0.0443***	-0.0117	3.79	0.1644***	-0.0502	3.27
ROAA	-0.0705***	-0.0201	-3.5	-0.2564**	-0.0998	-2.57
lnTA	-0.001	-0.0043	-0.22	-0.0331	-0.0279	-1.19
MFO	-0.0104	-0.0169	-0.61	-0.0443	-0.0757	-0.59
Constant	1.1137***	-0.0876	12.71	0.3964	-0.4506	0.88
σ_S^2	0.0164	-0.0305		0.0157	-0.0067	
gamma	0.9427			0.9226		
Log$L$	178.91			204.18		
R^2	0.204					
R-adjusted	0.1771					

Note. *, **, *** denote statistical significance at 10 %, 5 %, 1 %, respectively (two-sided significance level). R^2 and R-adjusted are reported for the secondary regression in Model type (1).

Most of year dummy variables share the same signs and (in)significances in both models, except for year dummy 2010. In Model type (1), only coefficients for year dummy 2010 and 2011 are significant and they are positive, while in Model type (2) only coefficient for year dummy 2011 is significant and it is positive. The significant and positive coefficients for year dummies indicate total costs have experienced a

significantly increase in these years comparing to the base year 2006. The significant increase in total cost is mainly a result of macroeconomic interference of China's central bank PBOC in 2010 and 2011. PBOC raised deposit reserve ratio six times for large financial institutions from 15.5 % to 18.5 % in year 2010, and continued raising it for six times from 18.5 % to 21.5 % in 2011. For small and medium sized financial institutions, deposit reserve ratio has been raised three times in 2010 from 13.5 % to 15.0 %, and then six times in 2011 from 15.0 % to 18.0 %. At the end of 2011, the deposit reserve ratio dropped by 0.5 % for all size financial institutions (East Money, 2012). In the same time, interest rates were raised from 2.25 % in 2010 to 3.25 % in 2011 for one year deposits (East Money, 2012). In one hand, banks face higher price of funds, on the other hand they are tightened up with liquidity which would lead to a decrease in extending loans in 2010 and 2011.

Parameter gamma $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ is reported for both models, which has value between 0 and 1 indicating the proportion of the variance in disturbance due to inefficiency. Gamma has values of 0.9427 and 0.9226 for Model type (1) and Model type (2) respectively, which suggest that variation of inefficiency is more important than stochastic variation in both models. Total error variance, $\sigma_S^2 = \sigma_v^2 + \sigma_u^2$, is reported as well.

5.3 Estimation Results of Cost Efficiency Scores

Figure 1 shows mean cost efficiency scores for individual banks over the entire sample period estimated by both models. CE-1 stands for cost efficiency estimated by Model type (1), and CE-2 for cost efficiency estimated by Model type (2). I assign a specific identification number (ID) for every bank in the sample, which is listed in detail in Appendix B. The numbers on the horizontal axis present IDs for these banks. Numbers 1 to 5 represent five banks in state-owned banks group. Number 6 to 13 represent eight joint stock banks. The rest represent city banks. Figure 1 clearly demonstrates that the estimation of cost efficiency from two models deviate from each other for individual banks but not to a large extent. Model type (2) obtains higher cost efficiency levels than Model type (1) in general except for some city banks.

Figure 1. Mean Cost Efficiencies for Individual Banks over the Entire Sample Period Estimated by Model Type (1) and Type (2)
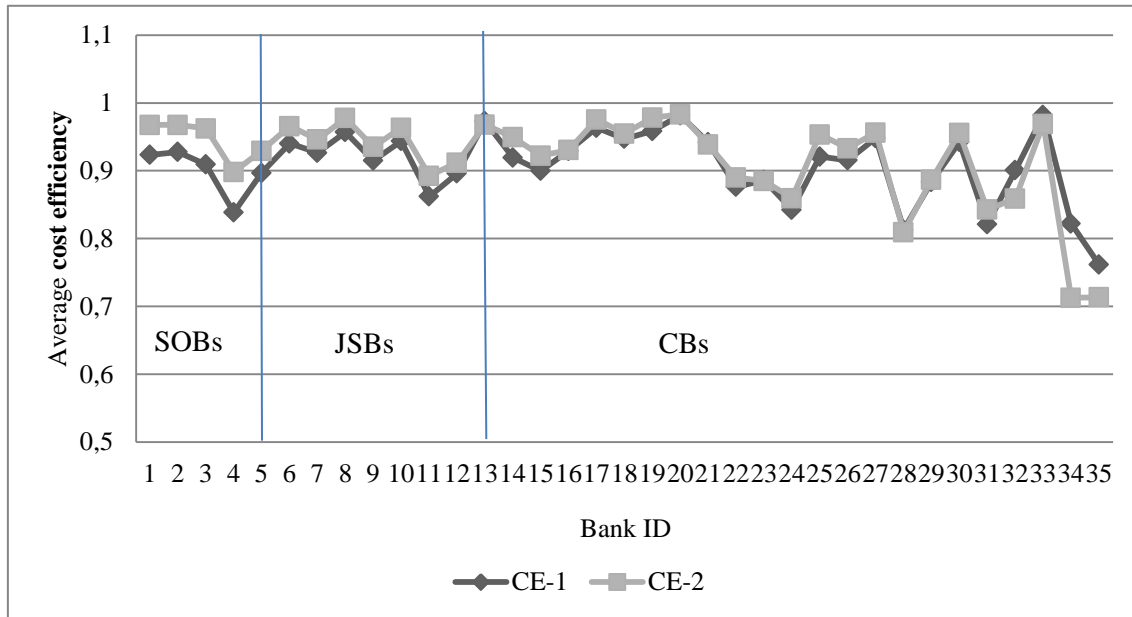
Note. CE-1 stands for mean cost efficiencies for each bank estimated by Model type (1), and similarly CE-2 by Model type (2)

Table 7 reports statistic descriptions of cost efficiencies obtained from the two models. The mean cost efficiency level for full sample of 90.9 % and 92.38 % for Model type (1) and type (2) suggest that typical banks waste about 9 % and 8 % relative to the best practice bank in the sample under the same conditions respectively. Cost efficiencies have similar distributions in two models, which range from 64.19 % to 98.90 % in Model type (1) and from 60.03 % to 98.73 % in Model type (2).

Table 7. Statistic Descriptions of Cost Efficiencies for Model Type (1) and Type (2)

Model	Obs	Mean	Std. Dev.	Min	Max
Model type (1)	154	0.9090	0.0617	0.6003	0.9873
Model type (2)	154	0.9238	0.0707	0.6419	0.9890

It is normal that individual bank obtains varying average cost efficiency from two models, because of different specifications. It is useful to further test whether ranking orders for individual banks are largely affected by different specifications. Therefore, I conduct Spearman rank correlation between two sets of cost efficiency scores estimated by Model type (1) and type (2) following previous authors in comparison studies (Bos,

Heid, Koetter, Kolari & Kool, 2005; Fries & Taci, 2005). The result for Spearman rank correlation is significantly high at 0.8951. The significant and positive correlation result suggests that the ranks of banks in the two models are consistent and reliable.

Table 8. Mean Cost Efficiencies for Full Sample and Subgroups over Entire Sample Period and for Each Year by Model Type (1) and Type (2)

Year	Total	2006	2007	2008	2009	2010	2011
Full Sample							
Model type (1)	0.9090	0.9115	0.9119	0.914	0.9087	0.8971	0.9163
Model type (2)	0.9238	0.9508	0.9144	0.9396	0.9588	0.9716	0.9713
Observation according to ownership							
State-owned banks (SOBs)							
Model type (1)	0.9011	0.8881	0.8707	0.8795	0.9098	0.9404	0.9159
Model type (2)	0.9466	0.9376	0.9183	0.9389	0.9618	0.9731	0.9480
Joint stock banks (JSBs)							
Model type (1)	0.9242	0.9134	0.9111	0.9356	0.9253	0.9393	0.9097
Model type (2)	0.9436	0.9247	0.9311	0.9506	0.9511	0.9553	0.9369
City banks(CBs)							
Model type (1)	0.9043	0.9199	0.9259	0.9140	0.9005	0.8679	0.9302
Model type (2)	0.9063	0.9209	0.9346	0.9102	0.8977	0.8721	0.9543

Table 8 reports mean cost efficiency scores in detail for full sample and subgroups over the entire sample period and for each year estimated by Model type (1) and type (2). With respect to changes of cost efficiency levels over time, I can only draw conclusions for state-owned banks and joint stock banks group. Since the sample is an unbalanced panel dataset, only with state-owned banks and joint stock banks groups I have relatively consistent observations in all the periods. With city banks group, observations and number of observations included in each year vary to a large extent. For instance, I have 20 observations for city banks group in 2008, but mere 3 observations in 2011 as it is presented in Table 1. To show the changes over time for the whole banking sector, I combine state-owned banks and joint stock banks as one group and calculate mean cost efficiencies across all years and graph them in Figure 2. The same as in Figure 1, CE-1 stands for cost efficiency estimated by Model type (1), and CE-2 by Model type (2).

Figure 2: Annual Means of Cost Efficiencies for Combined Group of SOBs and JSBs Estimated by Model Type (1) and Type (2)
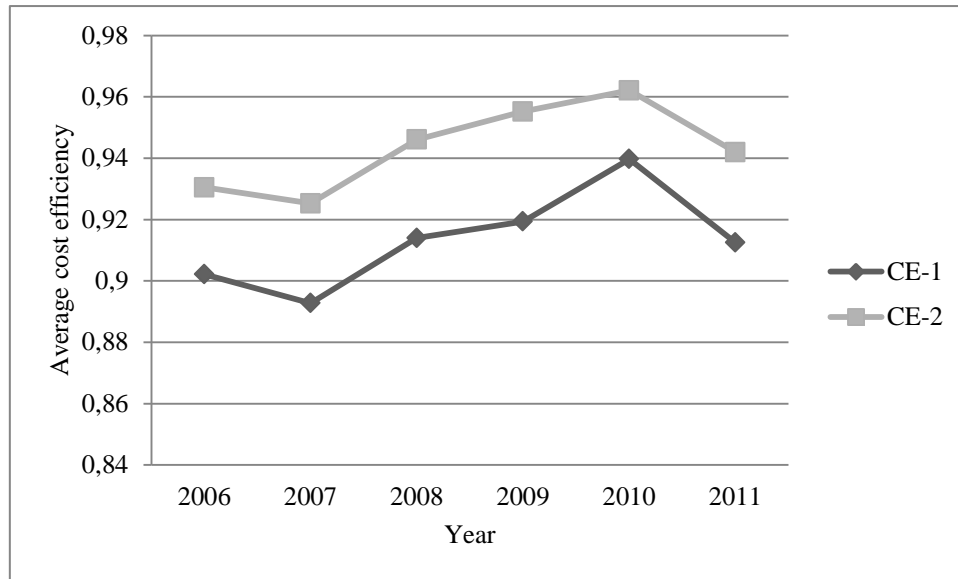
Note. CE-1 stands for mean cost efficiency for combined group of state-owned banks and joint stock banks estimated by Model type (1), and similarly CE-2 by Model type (2).

Figure 2 reveals that cost efficiencies for the entire banking sector, represented by the combined group of state-owned banks and joint stock banks, first decrease from 2006 to 2007, then increase from 2007 to 2010, finally drop again from 2010 to 2011. The reason for the second drop of cost efficiency is mainly a result of the interference of China's central bank PBOC, which also affect cost functions shown by the signs and significances of year dummy 2010 and 2011. As discussed before, interference measures implemented by PBOC include raising deposit reserve ratio by 6 % for large financial institutions and 4.5 % for small and medium sized financial institutions, and meanwhile raising interest rate by 1 % for one year deposits from 2010 to 2011. These measures have tightened up banks' liquidity so that they extend fewer loans, while in the same time banks confront higher input prices.

To confirm the improvement in cost efficiency level for the entire banking sector, I conduct an independent sample t-test under assumption of unequal variance following Allen and Rai (1996) between estimations from 2006 and 2010. Again, I combine state-owned banks and joint stock banks into one group which in total account for more than 60 % assets share of the whole banking sector. I test if the differences in mean cost efficiencies of 2006 and 2010 are significantly different. The result is shown in Table 9
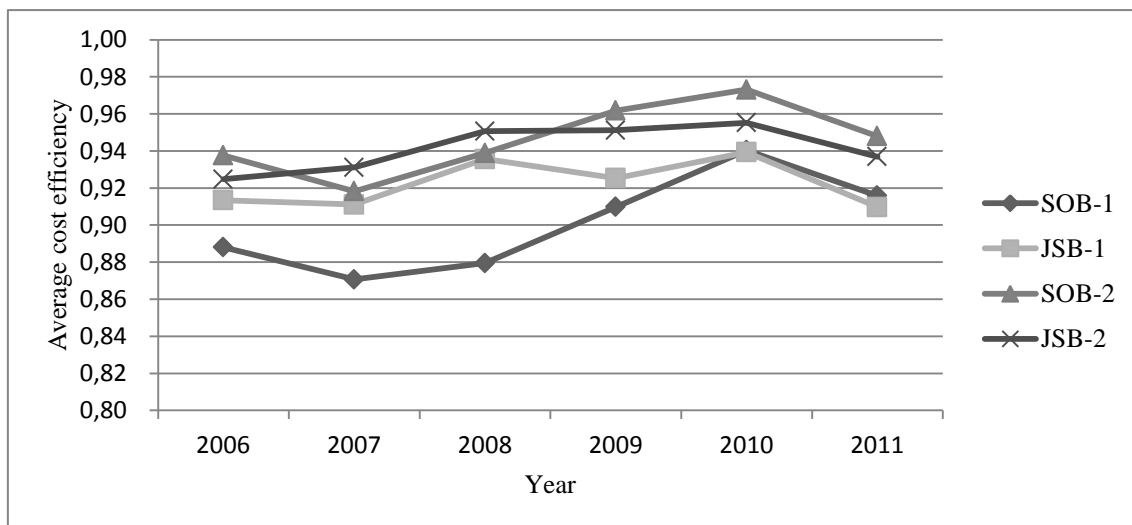
for both models, which indicate that cost efficiency level is significantly higher in 2010 than that of 2006 for the combined group of state-owned banks and joint stock banks. I also conduct the same test between estimations from 2006 and 2011. However, the results fail to prove cost efficiency level in 2011 is higher than that of 2006, largely due to the decrease from 2010 to 2011.

Table 9. Results of t-test for Combined Group of SOBs and JSBs in 2006 and 2010 by Model Type (1) and Type (2)

Group	Obs	Mode1 type (1)		Mode1 type (2)	
		Mean	Std. Err.	Mean	Std. Err.
2006	9	0.9022	0.0111	0.9305	0.0114
2010	13	0.9397	0.0114	0.9621	0.0088
diff		-0.0376	0.0159	-0.0317	0.0144
P-value		0.0289		0.0423	

To explain the first drop of cost efficiency, I further display average cost efficiency scores for state-owned banks and joint stock banks groups separately across years in Figure 3. SOB-1and JSB-1 stand for mean cost efficiencies for state-owned banks and joint stock banks groups estimated by Model type (1) respectively. Similarly, SOB-2 and JSB-2 denote mean cost efficiencies for state-owned banks and joint stock banks group estimated by Model type (2) respectively.

Figure 3. Annual Means of Cost Efficiencies for Separate SOBs Group and JSBs Group Estimated by Model Type (1) and Type (2)

Figure 3 shows that average annual estimation scores for subgroups of state-owned banks and joint stock banks from both models have similar trends. State-owned banks group experiences a decrease in cost efficiency from 2006 to 2007 in both sets of results. There are several plausible reasons causing the decrease. First, state-owned banks group consist of five banks only, the average efficiency score is prone to be affected considerably when there's minor change of formation of the group. ABC doesn't have data for 2006, so it's not included in when calculating average cost efficiency for 2006. ABC is the least efficient among state-owned banks, which is shown in Figure 1 by observation 4. Therefore, when ABC is included in 2007 the group average efficiency considerably decreases. Secondly, three state-owned banks have been listed in 2006, which are ICBC, CCB and BOC. Total costs might increase due to IPO process, which lead to the decrease or to the same level in 2007. Figure 3 also reveals that joint stock banks group remains a relatively stable cost efficiency level during all sample period.

In terms of city banks group, I attempt to draw a graph of annual means of cost efficiency in Figure 4 to show the change of mean cost efficiencies over time. It demonstrates completely different trend from those of state-owned banks and joint stock banks groups. This is largely due to aforementioned reason that number of observations included in each year for city banks group vary to a large extent. For instance, 20 observations are included in 2008, but mere three observations in 2011 as it is presented in Table 1.

Figure 4. Annual Group Means of Cost Efficiencies for CBs Estimated by Model Type (1) and Type (2)
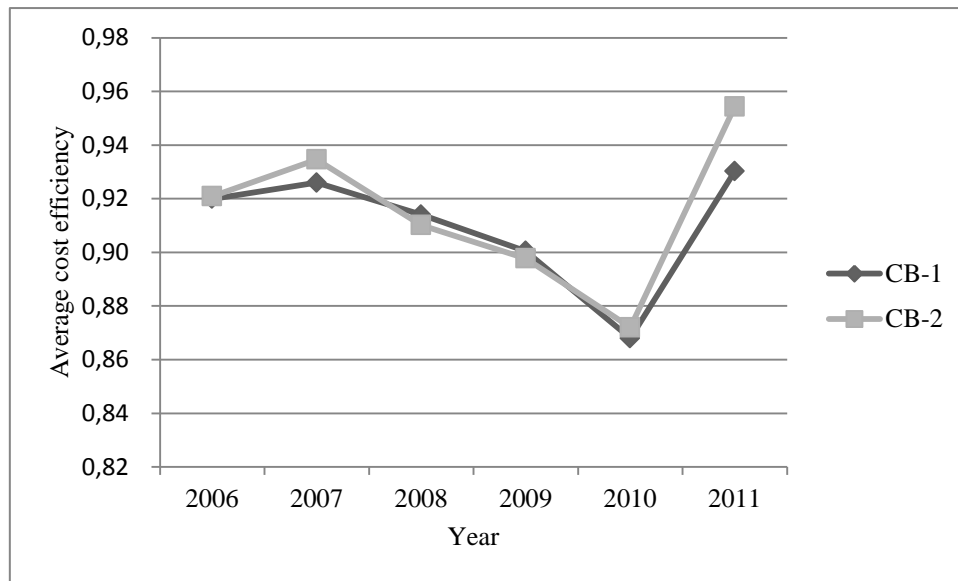
Note. CB-1 stands for mean cost efficiencies for city banks group estimated by Model type (1), and similarly CB-2 by Model type (2).

According to the results in Table 8, it's difficult to draw a conclusion which subgroup is more cost efficient. According to results from Model type (1), joint stock banks group has higher mean of cost efficiency than city banks group, then state-owned banks group follows. In Model type (2), city banks group is the least cost efficient. However, the group means of state-owned banks and joint stock banks are very close to each other in Model type (2), which are 0.9466 and 0.9436 respectively.

To further confirm which subgroup is the most cost efficient, I conduct independent sample t-test under the assumptions of unequal variances to test if differences in average cost efficiencies of subgroups are significant. Because t-test can only compare between two groups and there are three subgroups according to ownership, I compare every two of them separately. Results are shown in Table 10. I find that in Model type (1), joint stock banks are most cost efficient. Means of cost efficiency for state-owned banks and city banks are not significantly different from each other. In Model type (2), city banks are the least cost efficient. However, it fails to prove that means of cost efficiency for state-owned banks and joint stock banks groups are significantly different from each other.

Table 10. Results of t-test for Banks Grouped by Ownership for Model Type (1) and Type (2)

Group	Obs	Mode1 type (1)		Mode1 type (2)	
		Mean	Std. Err.	Mean	Std. Err.
SOBs	29	0.9011	0.0087	0.9466	0.0078
JSBs	41	0.9242	0.0067	0.9436	0.0057
diff		-0.0231	0.011	0.0030	0.0097
P-value		0.0394		0.7620	
SOBs	29	0.9011	0.0087	0.9466	0.0078
CBs	84	0.9043	0.0079	0.9063	0.0093
diff		-0.0031	0.0117	0.0403	0.0122
P-value		0.7896		0.0013	
JSBs	41	0.9242	0.0067	0.9436	0.0057
CBs	84	0.9043	0.0079	0.9063	0.0093
diff		0.0200	0.0104	0.0374	0.0109
P-value		0.0563		0.0009	

5.4 Estimation Results of Potential Correlates

Now, I turn to the discussion of potential correlates. The potential correlates are equity ratio (ER), net interest margin (NIM), ROAA, natural log of total assets (lnTA), and dummy variable of minority foreign ownership (MFO). The definitions of potential correlates are described in Table 4. I include the same set of potential correlates in order to compare results from the two specifications. Results of coefficients for potential correlates are presented in Table 6. These two models obtain consistent signs and (in)significances for all five potential correlates besides different approaches are employed. For Model type (1), I run OLS regression of inefficiency and potential correlates after obtaining inefficiency scores for individual banks.[1] R^2 and R-adjusted have value of 0.2040 and 0.1771, which are a bit low. For Model type (2), the potential correlates are included as a function of inefficiency in the main cost frontier function, estimation of coefficients for cost function and potential correlates are reported simultaneously.

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[1] In order to compare to single-step approach which explore the relationship of inefficiency and potential correlates, I investigate relationship of inefficiency and potential correlates in Model type (1) as well.

In both models, coefficients for equity ratio (ER), net interest margin (NIM), and ROAA are significant, while those for natural log of total assets (lnTA) and minority foreign ownership (MFO) are not. Except for NIM, all other coefficients are negative. The coefficient for ER is significantly negative, which indicates that higher equity ratio will result in lower inefficiency. In other words, bank with higher equity ratio is more cost efficient. NIM is considered as a rough measure of bank efficiency where a lower NIM indicates better performance of a bank and vice versa. In previous study, NIM is found significantly positive related to cost inefficiencies (Košak *et al.*, 2009). Result in this paper is consistent with previous finding, which means banks with lower NIM are more cost efficient. Intuitively, lower costs mean higher profits. Higher cost efficiency level means lower costs and higher profitability. Consequently, a negative relationship between cost inefficiency and profitability would be expected. On the other hand, the "quiet life" assumption suggests that the banks with higher profitability tend to relax their control over costs. As a result, a positive influence of profitability on cost inefficiency would be observed (Weill, 2004). In the paper, ROAA is significantly negatively associated with cost inefficiencies. Thus, banks may probably focus on cost control meanwhile pursue profitability in China, which is against "quiet life" assumption. Greater cost efficiency is connected with higher profitability and banks with higher returns seem to be more efficient.

Although the coefficient for lnTA is not significant, the negative signs are obtained in both models, which suggest that larger bank size may be positively associated with cost efficiency. Again I conduct independent sample t-test under the assumptions of unequal variances to test if differences in average cost efficiencies of subgroups are significant among small, medium and large banks groups. Results are shown in Table 11. Because t-test can only compare between two groups and there are three subgroups according to bank size, I compare every two of them separately. The results suggest that small banks are significantly less efficient than large and medium banks groups. However, it fails to prove that the difference in cost efficiency between large and medium banks groups is significant. In other words, the large banks group and medium banks group have similar mean cost efficiencies and both are more cost efficient than small banks group.

Table 11. Results of t-test for Banks Grouped by Bank Size for Model Type (1) and Type (2)

Group	Obs	Model type (1)		Model type (2)	
		Mean	Std. Err.	Mean	Std. Err.
Large banks	60	0.9126	0.0058	0.9475	0.0049
Medium banks	48	0.9257	0.0074	0.9382	0.0067
diff		-0.0131	0.0094	0.0093	0.0084
P-value		0.1677		0.2683	
Large banks	60	0.9126	0.0058	0.9475	0.0049
Small banks	46	0.8869	0.0121	0.8777	0.0145
diff		0.0257	0.0134	0.0698	0.0153
P-value		0.0599		0.0000	
Medium banks	48	0.9257	0.0074	0.9382	0.0067
Small banks	46	0.8869	0.0121	0.8777	0.0145
diff		0.0388	0.0142	0.0605	0.0160
P-value		0.0077		0.0003	

Berger *et al.* (2009) find out improvement in cost efficiency associated with adding minority foreign ownership in China's banking sector over the period of 1994 to 2003. Therefore, dummy variable of minority foreign ownership (MFO) is expected to be negatively associated with cost inefficiency. Coefficients for MFO in the paper have expected negative signs although not significant in both models. Since coefficients are not significant, to further investigate the influence of MFO I carry out independent sample t-test under the assumptions of unequal variances. Results are reports in Table 12. P-values are 0.044 and 0 for two sets of results from Model type (1) and type (2) respectively, which reflect the statistically significant differences in means of two groups at the 5 % level for both models. Banks taking on minority foreign ownership have higher cost efficiency levels.

Table 12. Results of T-test for Banks Grouped by MFO for Model Type (1) and Type (2)

Group	Obs	Mode1 type (1)		Mode1 type (2)	
		Mean	Std. Err.	Mean	Std. Err.
Banks with no foreign ownership (MFO=0)	84	0.9003	0.0079	0.9028	0.0848
Banks taking on minority foreign ownership (MFO=1)	70	0.9195	0.0052	0.0043	0.0356
diff		-0.0192	0.0095	-0.0461	0.0102
P-value		0.0440		0.0000	

5.5 Comparison with Previous Studies on China's Banking Sector

The majority of existing literature focuses on the pre-WTO period of China's banking sector and is restricted to 14 major commercial banks as discussed in literature review part. Qian (2003) estimates X-inefficiency of eight Chinese banks over the period 1995-2000. Liu and Song (2004) estimate X-inefficiency of 14 major commercial banks from 1996 to 2002. Kumbhakar and Wang (2007), evaluate performance of 14 major Chinese banks from 1993 to 2002. Fu and Heffernan (2006) employ SFA approach on 14 major Chinese banks over 1985 to 2002.

Peng (2007) studies cost efficiency in more recent years over 1993 to 2006 on 14 major commercial banks, while a few studies include relatively large number of banks: Yao *et al.* (2004) studies 22 commercial banks between 1995 and 2001; Chen *et al.* (2005) estimate cost efficiency of 43 banks over the period 1993 to 2000. Berger *et al.* (2009) focus on 38 Chinese banks over 1994-2003. The common conclusions from earlier period are: there is little evidence of economies or diseconomies of scale; state-owned banks are the least efficient, however, the efficiencies of different groups' are converging.

In this paper, I focus on more recent period from 2006 to 2011 and have a relative large sample of 35 Chinese commercial banks, which is a novelty in efficiency studies using Chinese data. I find similar results with these common conclusions that joint stock banks are the most cost efficient among subgroups according to ownership. Since I include city banks as the third group in addition to state-owned banks and joint stock

banks groups, I find that city banks group is the least cost efficient in Model type (2). And state-owned banks group is catching up during the latter half of the sample period, thanks to a series of remarkable reforms concerning structures, ownership and privatization of state-owned banks. In addition, equity ratio and ROAA are found to be significantly and negatively associated with cost inefficiency level, which indicates that higher equity ratio and ROAA will result in higher cost efficiency. Net interest margin has significantly positive relationship with cost inefficiency level, in other words, a lower net interest margin indicates better performance of a bank in terms of cost efficiency and vice versa. Other findings are large and medium banks groups have significant higher cost efficiency than small banks group; taking on MFO have positive impact on bank's cost efficiency.

CONCLUSIONS

This paper measures cost efficiency level of China's banking sector in post-WTO period of 2006 to 2011 by analyzing a sample of 154 annual observations for 35 Chinese commercial banks. The main contribution of this paper is that it focuses on more recent years and it uses a relative large sample of 35 Chinese commercial banks. In addition, potential correlates to cost inefficiency are investigated by using both two-step approach in Model type (1) and a single-step approach in Model type (2). These are two well-known methods in the literature investigating potential correlates to inefficiency. I find relatively consistent estimation results concerning cost efficiency level, ranking orders, and effects of potential correlates from these two models.

I conclude by presenting results of five hypotheses tested in the paper. With respect to hypothesis (1), it shows that cost efficiencies improve in most sample period, but decrease from 2010 to 2011. I assume that the drop is mainly a result of a macroeconomic interference of China's central bank PBOC which has raised deposit reserve ratio and interest rates several times in order to curb excessive investment in the overheating economy and tackle the severe inflation. Through independent sample t-test under assumption of unequal variance following Allen and Rai (1996), I find mean cost efficiency level of 2010 is significantly higher than that of 2006, but fail to prove cost efficiency level of 2011 is higher than that of 2006. With subgroups, annual average cost efficiencies for state-owned banks surpass those of joint stock banks in the latter half of the sample period. It is evident that reforms of state-owned banks towards

market-oriented have profound effects over the sample period.

By testing hypothesis (2), I observe that in Model type (1), joint stock banks are most cost efficient. Means of cost efficiency for state-owned banks and city banks are not significantly different from each other. In Model type (2), city banks are the least cost efficient. However, it fails to prove that means of cost efficiency for state-owned banks and joint stock banks groups are significantly different from each other.

In terms of hypothesis (3), results indicate that large and medium banks groups have significant higher cost efficiency than small banks group. Between large and medium banks groups, difference in group means of cost efficiency is insignificant.

Results of testing hypothesis (4) show that taking on minority foreign ownership have significant positive impact on cost efficiency. Banks with minority foreign ownership have higher cost efficiency than the other group with no foreign ownership.

In terms of hypothesis (5), I compare results from two models and find they produce highly consistent estimation results concerning cost efficiency levels, ranking orders, and relationships between cost inefficiency and potential correlates.

For the entire sample, average cost efficiencies are 90.9 %, 92.38 % for Model type (1) and type (2) respectively. Cost efficiencies have similar distributions which range from 64.19 % to 98.90 % in Model type (1) and from 60.03 % to 98.73 % in Model type (2). In terms of potential correlates, the two models obtain consistent signs and (in)significances for all five potential correlates besides different approaches are employed. Equity ratio and ROAA are found to be significantly and negatively associated with cost inefficiency level, which indicates that higher equity ratio and ROAA will result in higher cost efficiency. Net interest margin has significantly positive relationship with cost inefficiency level, in other words, a lower net interest margin indicates better performance of a bank in terms of cost efficiency.

This paper measures cost efficiency in most recent years and it is relatively comprehensive by including 35 commercial banks. Nevertheless it suffers from relatively short time period. Additionally, observations of city banks are insufficient and vary largely in each year, which creates difficulties in concluding if there's

improvement in cost efficiency for city banks group. Some suggestions for future studies are to include foreign banks in the sample, investigate other firm-specific characteristics as potential correlates, and extend sample to longer period.

SUMMARY IN SLOVENE

Vse od gospodarske reforme leta 1978 in t.i. »go out« politike je Kitajska ključni akter v svetu že več kot eno desetletje, saj ima visoko stopnjo rasti. Gospodarske dejavnosti so bile vedno financirane z bančnimi posojili. Bančna posojila predstavljajo kar 87 % vseh zbranih finančnih sredstev v letu 2006, v primerjavi s 76 % v letu 2001, kar kaže na vse večjo vlogo, ki jo predstavljajo bančna posojila v podpori gospodarske rasti Hansakul (2006). Učinkovitost bančnega sektorja je ključnega pomena za ohranjanje visoke gospodarske rasti.

Leta 1948 je bila ustanovljena Ljudska banka Kitajske (*PBOC - People's Bank of China*). Združevala je vlogi centralne in poslovne banke. Kitajski bančni sistem je imel samo eno banko do reforme leta 1978. Vse banke so bile del upravne hierarhije, restrukturirane v sistem PBOC ali pa pod upravo Ministrstva za finance (*MOF – Ministry of Finance*). Celoten bančni sistem je bil reguliran v smeri nacionalnih interesov (Berger *et al*., 2009). S strani vlade ni bilo izdanih obveznic ali delnic zaradi ideoloških razlogov. Ko se je leta 1976 končala Mao-va vlada, je nova vlada zadržano promovirala nov sistem trga vrednostnih papirjev. Ekonomske reforme so bile usmerjene v decentralizacijo ekonomske administracije, delnega sprejetja tržnih mehanizmov, večje uporabe ekonomskih sredstev (davkov, kreditov, obrestnih mer) v upravljanju ter delno liberalizacijo privatnih poslovnih aktivnosti (Imai, 1985). Po porastu kitajskega gospodarstva se je pojavila potreba po denarnih sredstvih. Veliki štirje (*The Big Four . Bank of China – BOC, China Construction Bank – CCB, Agricultural Bank of China – ACB in Industrial and Commercial Bank of China – ICBC*), ki so nastali po reformi PBOC so absolutno dominirali bančniški sektor. Leta 1994 so bile ustanovljene posojilne banke. Njihov glavni namen je bil prevzeti projekte državnih bank za razvojne namene. To so bile neke vrste poslovne banke (Herrero-Garcia *et al*., 2006).

Zgodovinsko gledano državna podjetja niso bila usmerjena k profitu, ampak so odigrala družbeno vlogo v gospodarstvu. Prevzela so vlogo vzdrževanja zaposlenosti ter zagotavljanja pokojnin, socialnega zavarovanja, izobraževanja ter zdravstvene oskrbe (Kumbhakar & Wang, 2007). Večina državnih podjetij je imelo slabe poslovne rezultate. Veliki štirje pri odobritvi kreditov državnim podjetjem niso vzeli v obzir kredibilnost oz. profitabilnost projektov. Vse do leta 1996 so po zakonu o bančništvu, banke bile nagrajene za količino posojil brez zadostnega premisleka o riziku teh posojil. Šele po

letu 1996 so bili posojevalci odgovorni za slaba posojila (Hawkins & Turner, 1999). Kitajska vlada se je leta 1998 zavedala resnosti situacije in izvedla številne reforme. Do konca leta 2000 je 51.2 % od skupno 62,000 podjetij neuspešno zamenjalo lastništvo v upanju, da bo povrnila dolgove. Ker je veliko podjetij bilo nelikvidnih, so bili dolgovi odpisani (OECD, 2002). V luči reform je MOF ustanovilo štiri podjetja, ki bi upravljala s sredstvi (*AMC - Asset Management Companies*) Velikih štirih; Cinda za CCB, Huarong za ICBC, China Orient za BOC ter Great Wall za ABC. AMC so zakonsko neodvisne agencije, ki zbirajo neodplačana posojila in jih nato restrukturirajo.

Po vstopu v Svetovno trgovinsko organizacijo (STO) v letu 2001, je Kitajska pospešila reforme. V veliki meri so bile reforme izvedene zaradi prilagoditve z mednarodnimi predpisi in pravili, ter hkrati tudi zaradi boljše pripravljenosti na soočenje s konkurenco. Izvedena je bila serija reform v zvezi s strukturami, lastništvom ter privatizacijo za izboljšanje učinkovitosti kitajskih domačih bank. Leta 2006 so tri državne banke postale javne. V letu 2010 je bila ABC uvrščena na borzo, kar je bil pomemben mejnik   reform glede bank v državni lasti. Medtem so delniške (*joint-stock*) in mestne banke nadaljevale z notranjimi reformami za izboljšanje finančne trdnosti ter upravljanja. Nekatere izmed njih so pripravljale prvo javno ponudbo (*IPO - initial public offering*). Veliko pozitivnih in globokih sprememb se je zgodilo v obdobju med letom 2006 in 2011.

Študije o učinkovitosti segajo vse nazaj do leta 1950. Farrel (1957) je poudaril, da je pomembno vedeti kako lahko neka industrija poveča proizvodnjo s povečanjem učinkovitosti ne da bi potrebovala dodatna sredstva. Znotraj področja preučevanja stroškovne učinkovitosti sta se v literaturi o merjenju učinkovitosti razvili dve glavni smeri merjenja. Prva smer temelji na finančno računovodskih kazalcih, druga smer pa temelji na ocenjevanju in merjenju stroškovnih funkcij. Poleg preučevanja učinkovitosti se v bančništvu preučuje tudi neučinkovitost (Berger & Humphrey, 1997). Pri merjenju učinkovitosti bank avtorji uporabljajo široko paleto fnančnih kazalcev, kot so neto celotna marža poslovanja (*net operating margin*), neto obrestna marža poslovanja (net *interest margin*), kazalec donosnosti bančnih naložb (*ROA –return on average assests*, dobiček na povprečno aktivo ter kazalec donosnosti kapitala (*ROE –return on average equity*), dobiček na povprečni kapital. Kasneje so se razvile alternativne možnosti preučevanja učinkovitosti bank, kjer je najpomembnejša metoda mejna stroškovna krivulja učinkovitosti (Berger & Humphrey 1992; DeYoung 1997; Berger 1999).

Farrel (1957) predlaga, da se merjenje produkcijske funkcije izdela na podlagi vzorca s podatki, ki veljajo za neparametrične ali parametrične metode. Glavna značilnost parametričnih tehnik je, da se slučajnostni odkloni ločijo od neučinkovitosti. Obstajajo tri glavne parametrične tehnike: metoda mejne stroškovne krivulje (*SFA - Stochastic frontier approach*), metoda brez porazdelitve (*DFA - Distribution free approach*) ter metoda široke meje (*TFA - Thick frontier approach*). Metoda SFA temelji na predpostavki, da ima slučajnostni odklon simetrično porazdelitev, izraz neučinkovitosti pa sledi asimetrični porazdelitvi. Metoda DFA temelji na principu povprečenja napak ocenjenega regresijskega modela, s čimer dosežemo ločitev slučajnostne komponente od učinkovitostne (Bauer, Berger, Ferrier & Humphrey, 1998).

Študije o učinkovitosti finančnih institucij so se v veliki meri posvečale le razvitim državam, medtem ko se šele v zadnjih letih pojavljajo študije o državah v razvoju, saj imajo drugačno institucionalno strukturo. Skupno jim je bilo, da so bili bančni sektorji razdeljeni funkcionalno, državna banka pa je bila glavna (Bonin & Wachtel, 1999). Krediti so bili odobreni in razporejeni s strani države brez premisleka o zmožnosti vračila sposojevalcev, ki so bila v veliki večini podjetja v državni lasti (Fries & Taci, 2005). Kitajska sledi temu modelu. Obstaja zelo malo obsežnih študij, ki se osredotočajo na učinkovitost bančnega sektorja na Kitajskem. Poleg tega se obstoječe študije osredotočajo predvsem na raziskovanje učinkov reform izvedenih leta 1990 kot sta Bonin in Huang (2001) ter DaCosta in Foo (2002). Skupno tem študijam je tudi to, da se osredotočajo na izračunavanje finančnih razmerij (*financial ratio*) temelječih na računovodskih informacij na omejeno število bank. Glavni cilj je evalvacija uspešnost bank (Guo, 2000). Tovrstni tradicionalni izračuni na podlagi računovodskih podatkov imajo številne pomanjkljivosti. DeYoung (1997) argumentira, da je enostavna finančna razmerja težko interpretirati. Učinkovitost bančnih institucij je kompleksen pojav, pri katerem je potrebno biti pozoren na več dejavnikov. Če se samo primerja finančne kazalce dveh različnih bank, potem je to neprimerno, razen če sta si banki identični po produktih, velikosti, tržnih pogojih ter ostalih karakteristikah, ki lahko vplivajo na stroške banke. Podatki o poslovanju kitajskih bank so bili postopoma dostopni javnosti šele po vstopu v 21. stoletje, deloma zaradi reform o odprtosti ter reform finančnega sektorja. Qian (2003) je uporabil Cobb-Douglas produkcijsko funkcijo in določil X-neučinkovitost osmih kitajskih bank v obdobju 1995-2000. Rezultati so nakazali, da obstaja malo dokazov o ekonomiji obsega; velike državne banke imajo manjšo učinkovitost v primerjavi z majhnimi ter srednje velikimi delniškimi bankami; dejavniki,

ki vplivajo na stroškovno učinkovitost so struktura kapitala, lastništvo ter delež obresti glede na celoten dohodek. Liu in Song (2004) uporabita SFA pristop v analizi 14-ih večjih poslovnih bank, kjer sta merila X-neučinkovitost v obdobju 1996-2002. Ugotovila sta, da imajo večje državne banke nižjo učinkovitost v primerjavi z delniškimi bankami. Yao, Feng in Jang (2004) uporabita SFA pristop, da bi določila produkcijsko funkcijo 22-ih poslovnih bank v obdobju 1995-2001. Nadalje še raziščeta učinke lastniške strukture ter rigidnega proračuna na učinkovitost. Kot odvisni spremenljivki uporabita posojila ter profit pred davki. Ugotovitve nakazujejo možnost, da so banke v nedržavni lasti bolj učinkovite od bank v državni lasti. Do enakih ugotovitev prideta tudi Kumbhakar in Wang (2007) ter Berger *et. al* (2009). Ena izmed novejših raziskav z uporabo SFA pristopa analizira 14 večjih poslovnih bank na Kitajskem v obdobju 1993-2006. Rezultati kažejo, da so banke v nedržavni lasti v splošnem izboljšale stroškovno učinkovitost (Peng, 2007). Le peščica avtorjev primerja učinkovitost kitajskih bank z bankami v drugih državah. Ena študija primerja tri nemške banke z osmimi kitajskimi, da bi ocenili stroškovno mejno funkcijo v obdobju 1998-2005. Zaključna ideja je, da so v splošnem kitajske banke manj učinkovite, vendar pospešeno dohitevajo nemške banke. Najbolj presenetljiv podatek je, da je najbolj učinkovita kitajska banka Bank of Communication, kar bi lahko nakazovalo majhen vzorec oz. premalo pozornosti namenjejo določenim ključnim faktorjem učinkovitosti (Liu in Li, 2006).

Večina teh študij se osredotoča na 14 glavnih poslovnih bank na Kitajskem. Številka je majhna. Hkrati se večina raziskav osredotoči le na lastništvo ter tako kategorizira banke v državni lasti kot neučinkovite ter delniške banke učinkovite. Ko so vključene še tuje banke so slednje najbolj učinkovite ter tuja vpletenost ima pozitiven učinek na nivo učinkovitosti. Le redki raziščejo potencialne povezave, kot so kapitalna struktura, razmerje obresti glede na poslovni dohodek ter proračunske omejitve (Qian, 2003; Yao *et al,.* 2004).

V nalogi sem se osredotočila na obdobje po vstopu Kitajske v STO v obdobju 2006-2011 ter poskušala izvesti relativno celovito analizo bančnega sektorja na Kitajskem z uporabo SFA pristopa. Po letu 2003 se je v kitajskem bančnem sistemu zgodilo veliko sprememb. Tuji partnerji so bili dobrodošli kar je pomenilo dodaten vir sredstev, kar je še pomembneje tudi dodatna znanja o vodenju ter inovacijah v bančništvu (Hansakul, 2006).

V vzorec sem vključila 35 kitajskih poslovnih bank v obdobju 2006-2011, kar je skupaj 154 opazovanj. Vzorec vsebuje banke v državni lasti, in sicer Veliki štirje − Industrial and Commercial Bank of China (ICBC), Bank of China (BOC), China Construction Bank (CCB), Agricultural Bank of China (ABC) ter Bank of Communications. Veliki štirje so doživeli veliko reform, tudi v lastniški strukturi, tako da niso več v celoti državni lasti. Vzorec vsebuje tudi osem delniških bank od skupno 12, to so CITIC Bank, China Everbright Bank, Huaxia Bank, Guangdong Development Bank, China Merchants Bank, Shanghai Pudong Development Bank, China Minsheng Banking Corporation, China Zheshang Bank. Locirane so v večih mestih, prav tako njihove podružnice. Delež teh osmih bank znaša skupno 80 % sredstev vseh delniških bank, ter 10.5 % sredstev vseh bančnih institucij v letu 2010. Poleg tega sem v vzorec dodala še 22 od 114 mestnih bank na Kitajskem. Vse mestne banke skupno znašajo 8 % sredstev vseh bančnih institucij v letu 2010, medtem ko znaša teh 22 kar polovico deleža sredstev. Mestne banke so se razvile iz mestnih kreditnih zadrug. Lokalne vlade ostajajo največji lastniki. Večinoma poslujejo le v tistem mestu, kjer so locirane. V raziskanem obdobju so nekatere doživele reforme, ki so vključevale dokapitalizacijo, interne reforme ter vključevanje strateških partnerjev. Zaradi vezi z lokalnimi oblastmi imajo stabilen vir depozitov (Hansakul, 2006). Ostali delež sredstev je v lasti slednjih bančnih institucijah: podeželskih poslovnih bank, podeželskih zadružnih bank, mestnih kreditnih zadrug, podeželskih kreditnih zadrug, nebančnih finančnih institucij, finančnih institucij novega tipa, poštnih hranilnih bank ter v tujih bankah. Tuje banke ali njihove podružnice predstavljajo 0.7 %. Banke, ki sem jih vključila v vzorec predstavljajo 64.5 % vseh sredstev bančnih institucij na Kitajskem v letu 2010. Podatke sem primarno uporabila iz podatkovne baze Bankscope, ki jih objavlja Bureau van Dyke. Izraženi so v ameriških dolarjih, ker so na tak način bolj primerljivi rezultati z že obstoječo literaturo o kitajskem bančništvu. Vključila sem banke, ki imajo dosegljive podatke za najmanj štiri leta v omenjenem obdobju. V primeru manjkajočih podatkov v bazi Bankscope, uporabim vire kot so letni almanah China's Finance and Banking, letna poročila posameznih bank ter poročila CBRC. Teh 35 poslovnih bank je razdeljenih v tri skupine: banke v državni lasti, delniške banke ter mestne banke. Delniške družbe so v popolnoma privatni lasti ali pa v skupni lasti lokalnih vlad, privatnih podjetij ter tujih lastnikov. Tuje banke niso vključene v vzorec, ker so bile reforme večinoma usmerjene v domače banke. Ocenjujem stroškovno učinkovitost za posamezne banke v vsakem obdobju in tudi raziščem morebitno povezavo z neučinkovitostjo. Banke so razdeljene tudi glede na velikost, kar temelji na skupnih sredstvih banke v času t. Določena banka

je majhna, če so njena sredstva manj ali enakovredna 10 milijardam ameriških dolarjev v času *t*; srednje velika banka, če so sredstva večja od 10 milijard ameriških dolarjev, vendar manj ali enako 100 milijardam ameriških dolarjev v času *t;* banka je velika, če sredstva znašajo več kot 100 milijard ameriških dolarjev v času *t*.

Kar zadeva metodologijo sledim dvema modeloma: model tipa (1), ki uporablja dvostopenjski pristop in se opira na pol normalno porazdelitev, ki ga predlaga Aigner, Lovell in Schmidt, (1977), v prvi fazi za oceno stroškovne učinkovitosti, nato pa izvedem regresijo neučinkovitosti s potencialnimi korelati, ki bi lahko pojasnili razlike v uspešnosti in učinkovitosti; ter model tipa (2), ki uporablja enostopenjski pristop. Enostopenjski pristop sledi Battese in Coelli (1995) specifikacijo, ki omogoča hkratno ocenjevanje rezultatov stroškovne učinkovitosti in možnih povezav z neučinkovitostjo. V nalogi primerjam rezultate obeh znanih pristopov, da bi zagotovila zanesljive rezultate glede stroškovne učinkovitosti in možne povezave s stroškovno neučinkovitostjo. V obeh modelih tipa (1) in tipa (2) , so skupni stroški vsota stroškov obresti, osebja ter drugih neobrestnih stroškov. Vložki (*input*) so izposojena sredstva, delo ter fizični kapital. Izdatki (*output*) so posojila, vrednostni papirji ter ostala sredstva zaslužka. Cena izposojenih sredstev w_1, je merjena kot delež plačanih obresti ter celotnih depozitov. Cena delovne sile w_2, je merjena kot delež stroškov osebja glede na celotna sredstva. Cena fizičnega kapitala w_3, je merjen kot delež neobrestnih stroškov glede na fiksna sredstva (Altunbas, Evans & Molyneux 2001;Yildirim & Philippatos   2007).

Splošni SFA model lahko izrazimo v naslednji obliki (Coelli, Prasada Rao, O'Donnell & Battese, 2005):

$$ln\,TC_{it} = c(x_{it}; \beta) + v_{it} + u_{it}$$

kjer *TC$_{it}$* označuje opazovane celotne stroške v *t* opazovanjih *(t=1,2,...T)* za *i-to* podjetje *(i=1,2,...,N);*

x_{it} je $(1 \times \mathrm{k})$ vektor izhodnih količin ter vhodnih cen;

β je $(k \times 1)$ vektor neznanih parametrov, ki jim moramo oceniti;

$c(\cdot)$ je primerna funkcijska oblika;

v_{it} je stohastična napaka, ki zajame učinek šuma ter meritvenih napak, ki so iid. $\mathcal{N}(0, \sigma_v^2)$, ter neodvisne od

u_{it} ki je ne-negativen neučinkovitostni termin.

Aigner et al. (1997) je predvideval, da ima v_{it} normalno porazdelitev in u_{it} pol-normalno porazdelitev. Alternativne porazdelitve so predlagane kasneje. Čeprav kritizirana zaradi nefleksibilnosti, je pol-normalna porazdelitev neučinkovitosti dominantna v literaturi. Tej porazdelitvi sledim v modelu tipa (1).

Glavni cilji tega prispevka so preveriti, ali se je stroškovna učinkovitost izboljšala v vzorčnem obdobju za celoten bančni sektor. Potem sem razvrstila banke v podskupine bank po različnih kriterijih. Primerjam stroškovno učinkovitost med podskupinami, da bi našla tisto, ki je najbolj učinkovita v zadnjem obdobju. Glede na lastništvo so banke razdeljene v banke v državni lasti, delniške banke ter mestne banke. Glede na velikost bank, so banke razdeljene v male, srednje ter velike banke. Na koncu so banke razvrščene še v dve skupini, tiste, ki so v manjšinski tuji lasti in tiste, ki niso. Poleg tega raziščem še morebitne povezave s stroškovno neučinkovitostjo.

V nalogi sem testirala pet hipotez:

1) preverim, če se je stroškovni nivo učinkovitosti celotnega bančnega sektorja in podskupin izboljšala v obdobju 2006-2011. Ravni stroškovne učinkovitosti naj bi se okrepile po zaslugi reform. Banke v državni lasti so bile reformirane v smeri bolj tržno-orientiranega vodenja. Veliko delniških ter mestnih bank so namenile veliko časa reformiranju v smeri nove politike osrednje banke in teženju boljšemu vodenju.

2) preverim, katera podskupina je najbolj stroškovno učinkovita med poslovnimi bankami v državni lasti, delniškimi ter mestnimi bankami. Obstoječa literatura kaže, da so banke v državni lasti na splošno najmanj učinkovite, medtem ko so delniške banke najbolj učinkovite na podlagi prejšnjih letih vzorca in se razlika med skupinama spreminja. Smiselno je ugotoviti ali to kljub reformam v državnih bankah še vedno velja.

3) preverim, če je velikost banke povezana s stroškovno neučinkovitostjo. Prejšnje študije prikazujejo različne rezultate v različnih državah ali v določeni državi v različnih obdobjih. Tako sem preučila odnos med stroškovno učinkovitostjo ter velikostjo banke.

4) preverim, če so banke v manjšinski tuji lasti stroškovno bolj učinkovita kot banke, ki nimajo manjšinskega tujeg lastništva. Po letu 2003 so tuja lastništva sprejeli v partnerstva. Vendar pa obstajajo omejitve, koliko delnic imajo lahko tuji lastniki. Zgornja meja se je dvignila iz 20 % na 25 % v januarju 2004 za skupno število tujih lastniških delnic, ter za eno tuje lastništvo se je zgornja meja dvignil iz 15 % na 20 % (CBRC Annual report, 2006). Ker je lahko v tuji lasti manj kot 25 %, uporabim to kot značilnost bank v manjšinskem tujem lastništvu.

5) primerjam rezultate ocenjevanja glede na raven stroškovne učinkovitosti, razvrstitve ter razmerja med stroškovno neučinkovitostjo in potencialno povezavo z modeli eno in dvostopenjskega pristopa in preverim, če zagotavljajo razmeroma dosledne rezultate.

Stroškovno učinkovitost merim z zbranimi opažanji, v katere vključim year dummies, s katerimi se izognem pristranskosti določanj po Berger *et al.* 2009, ki bi bile lahko posledica potencialnih sprememb v delovanju bank zaradi tehnološki procesov ali sprememb v ekonomskem ter regulatornem okolju. Izognem se časovni spremenljivki v sekundarni regresiji v dvostopenjskem modelu tipa (1).

Struktura diplomskega dela je slednja. Najprej naredim kratek pregled literature, kjer poudarim študije o učinkovitosti bank v tranzicijskih državah ter državah v razvoju in hkrati naredim pregled obstoječe literature o kitajskem bančnem sektorju. Temu sledi uvod v zgodovino razvoja kitajskega bančnega sektorja. To poglavje oriše zgodovino, regulacijo ter ekonomsko okolje bančnega sistema na Kitajskem. V naslednjem poglavju opišem metodologijo in specifikacijo modela, ki ga uporabljam v nalogi. Naslednje poglavje predstavlja podatke in spremenljivke. Na koncu so predstavljeni empirični rezultati za obmejne stroškovne funkcije, ravni na področju stroškovne učinkovitosti, morebitne povezave ter primerjava rezultatov dveh modelove. Prispevek se zaključi s pripombami o petih hipotezah.
V nalogi merim stopnjo stroškovne učinkovitosti bančnega sektorja Kitajske po vstopu v STO v obdobju 2006-2011 z analizo vzorca 154 letnih opazovanj za 35 kitajskih poslovnih bank. V literaturo o stroškovni učinkovitosti prinaša nov pogled, saj se

osredotočim na novejše obdobje z relativno velikim vzorec 35 kitajskih poslovnih bank. Poleg tega raziščem možne povezave z neučinkovitostjo z uporabo tako dvostopenjskega kot tudi enostopenjskega modela. To sta dva znana modela v literaturi o raziskovanju potencialnih povezav z neučinkovitostjo. Najdem dokaj konsistentne rezultate ocenjevanja glede stopnje stroškovne učinkovitosti, razvrstitve ter učinke potencialnih povezav obeh modelov. Potrdim torej, da različne specifikacije modela zagotavljajo podobne rezultate. V nasprotnem primeru bi bilo zavajajoče za politike in regulatorje pri oblikovanju politike, če bi se zanašalo na rezultate ocenjevanja le z eno določeno specifikacijo.

Nalogo sklenem s predstavitvijo rezultatov 5 hipotez testiranih v nalogi. V zvezi s hipotezo (1), je razvidno, da se je stroškovna učinkovitost izboljšala v obdobju 2006-2009, vendar zmanjšala v obdobju 2010-2011. Padec je predvsem posledica makroekonomskega vmešavanje centralne banke Kitajske, ki je z nenehnim dvigovanjem stopnje rezerv ter obrestne mere večkrat letno, da bi omejili preveliko vlaganje v pregrevajoče se gospodarstvo in reševali hudo inflacijo. S pomočjo neodvisnega vzorca t-test pod predpostavko o neenaki varianci po Allen in Rai (1996), se mi zdi povprečna stroškovna učinkovitost raven leta 2010 bistveno višja kot leta 2006, vendar pa ne dokaže raven stroškovne učinkovitosti leta 2011, da bi bila višja kot leta 2006. V podskupinah, povprečna letna stroškovna učinkovitost za banke v državni lasti presega povprečno letno stroškovno učinkovitost delniških bank v drugi polovici vzorčnega obdobja. Očitno je, da reforme bank v državni lasti v tržno smer močno vplivajo v vzorčnem obdobju.

Po testiranju hipoteze (2), opažam, da so po modelu tipa (1), delniške banke najbolj učinkovite. Povprečna stroškovna učinkovitost za banke v državni lasti ter mestne banke niso bistveno različne med sabo. V modelu tipa (2), so mestne banke najmanj stroškovno učinkovite. Vendar, pa ne dokaže ali je bistveno drugačna povprečna stroškovna učinkovitost med bankami v državni lasti ter mestnimi bankami.

V zvezi s hipotezo (3), rezultati kažejo, da imajo velike in srednje banke veliko večjo stroškovno učinkovitost, kot majhne banke. Med velikimi in srednjimi bankami je razlika v povprečni stroškovni učinkovitosti nepomembna.

Rezultati testiranja hipoteze (4) kažejo, da ima manjšinski tuji delež pomemben

pozitiven vpliv na stroškovno učinkovitost. Banke v manjšinski tuji lasti imajo višjo stroškovno učinkovitost, kot druge skupine, brez tujega lastništva.

V zvezi s hipotezo (5), s primerjavo rezultatov obeh modelov sem ugotovila, da proizvajajo visoko konsistentne rezultate ocenjevanja glede na raven stroškovne učinkovitosti, razvrstitve ter razmerja med stroški in morebitno neučinkovitostjo.

Za celoten vzorec so povprečne stroškovne učinkovitosti 90.9 %, 92.38 % za model tipa (1) in tipa (2). Stroškovne učinkovitosti imajo podobno distribucijo, ki sega od 64.19 % do 98.90 % v modelu tipa (1) in od 60.03 % do 98.73 % v modelu tipa (2). V zvezi z morebitnimi povezavami, oba modela obdržita dosledne znake ter (ne)pomembnost za vseh pet potencialnih povezav kljub različnimi pristopi. Lastniški delež in donos na aktivo sta pomembno in negativno povezana z nivojem stroškovne neučinkovitosti, kar pomeni, da bo večji delež lastnih sredstev in donos na aktivo za posledico imel višjo stroškovno učinkovitost. Neto obrestna stopnja ima pomembno pozitivno povezavo z nivojem stroškovne neučinkovitosti, z drugimi besedami, nižja neto obrestna stopnja pomeni boljše delovanje banke v smislu stroškovne učinkovitosti.

Naloga meri stroškovno učinkovitost kitajskih bank v zadnjih letih in je relativno celovita, saj vključuje kar 35 poslovnih bank. Kljub temu je obdobje opazovanja dokaj kratko. Poleg tega so opazovanja mestnih bank nezadostna in se razlikujejo v vsakem letu, kar povzroča težave pri sklepanju ali se je stroškovna učinkovitost izboljšala v mestnih bankah. Predlogi za prihodnje preučevanje so vključiti tuje banke v vzorec, raziskati druge značilnosti za podjetje kot potencialne povezave ter razširiti vzorec na daljše obdobje.

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APPENDIXES

TABLE OF APPENDIX

Appendix A: List of Abbreviation

ABC: Agricultural Bank of China

AMC: Asset Management Company

BOC: Bank of China

BOCOM: Bank of Communications

CAR: Capital Adequacy Ratio

CBRC: China Banking Regulatory Commission

CBs: City banks

CCB: China Construction Bank

CDB: China Development Bank

CE: Cost Efficiency

CSRC: China Securities Regulatory Commission

ER: Equity Ratio

ICBC: Industrial and Commercial Bank of China

ID: Identification number

IPO: Initial Public Offering

JSBs: Joint Stock Commercial Banks

MFO: Minority Foreign Ownership

MOF: Ministry of Finance

NIM: Net Interest Margein

NPL: Non-performing Loan

PBOC: People's bank of China

ROAA: Return on Average Assets

ROAE: Return on Average Equity

SMEs: Small-and Medium- sized Enterprises

SOBs: State-owned Commercial Banks

SOEs: State-owned Enterprises

TA: Total Assets

WTO: World Trade Organization

Appendix B: List of Banks Included in the Sample

ID	Type	Name of bank
1		Industrial and Commercial Bank of China (ICBC)
2		China Construction Bank Corporation (CCB)
3	SOBs	Bank of China Limited (BOC)
4		Agricultural Bank of China Limited (ABC)
5		Bank of Communications Co. Ltd (BOCOM)
6		China Merchants Bank Co Ltd
7		China CITIC Bank Corporation Limited
8		Shanghai Pudong Development Bank
9		China Minsheng Banking Corporation
10	JSBs	China Everbright Bank Co Ltd
11		Hua Xia Bank co., Limited
12		China Guangfa Bank Co Ltd
13		China Zheshang Bank Co Ltd
14		Bank of Beijing Co Ltd
15		Bank of Ningbo
16		Bank of Chongqing
17		Bank of Shanghai
18		Ping An Bank
19		Bank of Nanjing
20		Bank of Hangzhou Co Ltd
21		Huishang Bank Co Ltd
22		Bank of Dalian
23	CBs	Harbin Bank
24		Hankou Bank
25		Bank of Dongguan
26		Fudian Bank Co Ltd
27		Bank of Nanchang co., Ltd
28		Guiyang Commercial Bank Co Ltd
29		Bank of Qingdao Co Ltd
30		Fujian Haixia Bank Co Ltd
31		Xiamen Bank

Table continues

continued

ID	Type	Name of bank
32		Bank of Wenzhou Co Ltd
33		Bank of Shaoxing Co Ltd
34	CBs	Qishang Bank.
35		Bank of Fuxin Co. Ltd

Appendix C: Simple Correlation of Cost Inefficiency and Potenatial Correlates for Model type (1) and type (2)

Model type (1)	Cost inefficiency	ER	NIM	ROAA	lnTA	MFO
Cost inefficiency	1					
Equity Ratio (ER)	-0.1699	1				
Net Interest Margin (NIM)	0.4812	0.1741	1			
ROAA	-0.2214	0.3618	0.318	1		
Natural log of total assets (lnTA)	-0.3713	-0.1234	-0.3259	0.0132	1	
Minority Foreign Ownership (MFO)	-0.3151	0.0754	-0.2199	0.0353	0.6466	1

Model type (2)	Cost inefficiency	ER	NIM	ROAA	lnTA	MFO
Cost inefficiency	1					
Equity Ratio (ER)	-0.2484	1				
Net Interest Margin (NIM)	0.2072	0.1741	1			
ROAA	-0.2646	0.3618	0.3180	1		
Natural log of total assets (lnTA)	-0.1435	-0.1234	-0.3259	0.0132	1	
Minority Foreign Ownership (MFO)	-0.169	0.0754	-0.2199	0.0353	0.6466	1